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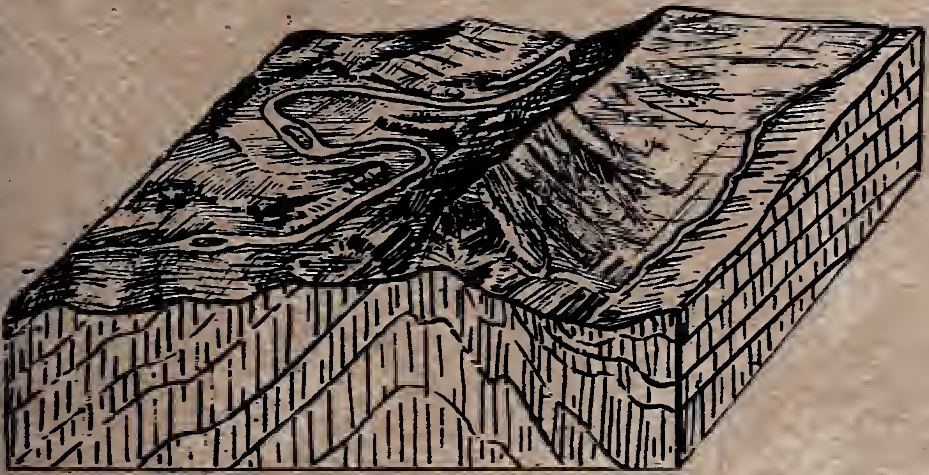
DEPARTMENT OF INTERNAL AFFAIRS

THE GEOLOGY OF THE HIDDEN VALLEY

BOY SCOUT CAMP AREA, PERRY COUNTY



By
JOHN T. MILLER

TOPOGRAPHIC AND GEOLOGIC SURVEY

BULLETIN G 30

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PENNSYLVANIA GEOLOGICAL SURVEY
FOURTH SERIES

THE GEOLOGY of the HIDDEN VALLEY BOY SCOUT CAMP AREA, PERRY COUNTY, PENNSYLVANIA

By

John T. Miller

COMMONWEALTH OF PENNSYLVANIA

DEPARTMENT OF INTERNAL AFFAIRS
GENEVIEVE BLATT, *Secretary*

TOPOGRAPHIC AND GEOLOGIC SURVEY
CARLYLE GRAY, *State Geologist*

1957

FOREWORD

To maintain our mode of life and to insure future progress, an awareness of the science of geology is as necessary as an awareness of chemistry, physics, or any of the other sciences. The means to such awareness is public education which provides two major benefits; first it enables the general public to understand present day knowledge and investigations, and second, it stimulates an interest among the youngsters of today who will be the scientists of tomorrow.

For those who do not understand the meaning of the term "geology", it is defined as the study of the earth. Except for a thin surface cover of soil, the earth is composed almost entirely of rock, and a knowledge of rocks is important to an understanding of the nature of the earth. Such knowledge becomes significant when we realize that the use of rocks and the minerals which they contain enabled man to progress from the "stone age" to the "age of metals" and eventually to the "atomic age".

The article which follows presents a simplified verbal picture of the geology in the Hidden Valley Boy Scout Camp area, Perry County, Pennsylvania. It is written in response to a general appeal for public education by the American Geological Institute. Necessarily the article is written in a non-technical style, and wherever technical terms are used, they are accompanied by either alternative common terms, or by an explanation.

Genevieve Blatt

Genevieve Blatt, Secretary
Department of Internal Affairs

October, 1957

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THE GEOLOGY OF THE HIDDEN VALLEY BOY SCOUT CAMP, PERRY COUNTY, PENNSYLVANIA

By

John T. Miller*

AN INTRODUCTION TO GEOLOGY

Sign Posts of Geology

Historians and archeologists interpret old documents, ancient signs of cities, and the ruins of human cultures to compile a historical account of man. In much the same way, geologists interpret signs which can be seen in rocks to compile the part of the earth's history which occurred before man's appearance on the scene.

Many signs found in the rocks of the Hidden Valley area need to be explained. For example: Why are sea shells found in the rocks? Is it possible that Hidden Valley was once covered by the sea? Why do the ledges of rocks near camp seem to stand on end? When and how was Bowers Mountain formed? Will the mountain last forever as it is now, or will it gradually be changed by nature? These and many other questions can be answered by examining the rocks of the Hidden Valley area. But first it is necessary to consider some fundamental principles of geology, in order to make the geology of the camp area more easily understood.

Topography

Topography is the shape of the land surface; topographic maps are a two-dimensional, graphic representation of the land surface. Height above sea level is shown on such maps by lines called elevation contours which represent level lines. Contour lines as seen on a map look much the same as contour strips on a modern farm as seen from an airplane.

A geologist uses topographic maps when working in the field in order to know his accurate geographic location at all times. Note that the geologic map

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*Geologist, Pennsylvania Geological Survey. The writer acknowledges the assistance of the members of the Pennsylvania Geological Survey, especially Robert C. Bolger whose constructive criticism greatly aided in organization of the paper. Information used in the paper represents part of the results of a geologic field investigation of the rocks which occur in east-central Pennsylvania.

(plate 2) shows elevation contours as well as the map pattern of the rock belts in the camp area.

Topography is also useful because it tells a story to geologists. Shale is a soft rock and is worn down or eroded rapidly. Thus it underlies many stream valleys. On the other hand, belts of hard sandstone are eroded less rapidly, and form resistant ridges. There are other reasons for the presence of hills and valleys, but the important thing is to realize that topography is useful to geologists when interpreting the history of an area.

The Nature of Rocks

A rock is a natural substance composed of mineral particles or grains. Minerals, in turn, are composed of chemical elements or compounds. For example, the rock sandstone is commonly composed of fragments or sand grains of the mineral quartz, which is composed of the chemical elements silicon and oxygen. Thus, ordinary chemical elements combine to form minerals, which in turn, are combined to form rocks.

Geologists have divided or classified rocks into three main groups: sedimentary, igneous, and metamorphic rocks.

1. Sedimentary rocks - are those which originate as sediments deposited or laid down by water or wind. Sediments are accumulations of clay, sand, and gravel, which are fragments of previously existing rocks. Common types of sedimentary deposits are stream deposits, ocean deposits, and wind-blown desert deposits which harden to form sedimentary rocks such as sandstone, and shale or claystone.

2. Igneous rocks - Igneous means "like fire" and igneous rocks are those which form by the hardening of melted material called magma and lava. When heat and pressure in the earth cause minerals to melt, the melted material may either flow onto the surface of the earth as lava and form volcanic rock deposits, or stay below the surface as magma and harden to form other types of igneous rock such as granite.

3. Metamorphic rocks - Metamorphism means "a change in form", and metamorphic rocks are those which originate as either igneous or sedimentary rocks whose minerals later are changed to new minerals by the action of heat and pressure. Slate and schist are common metamorphic rocks.

The only types of rocks found in the Hidden Valley area are sedimentary rocks. Thus igneous and metamorphic rocks will not be discussed further.

The Nature of Sediments and Their History

Most sedimentary rocks are formed from sediments deposited by water. The sediments are deposited in layers, and one can see why by thinking of the action of present day streams and ocean currents. When heavy rains occur, soil and rock fragments are washed into streams from hills and valley sides thus making the streams muddy. If a flood occurs and a stream overlows its banks, a layer of sediment is deposited in the flooded area. The sediment not deposited in the flooded area is carried downstream to the ocean, where ocean currents distribute the sediment, depositing it in layers on the ocean bottom and along beaches. When the next flood occurs, these layers are covered by a new layer.

It is common to see leaves, tree branches, and even trees carried along by flood waters. Every year many animal and even human lives are lost in floods. Thus plants and animals are swept away year after year by floods and commonly are covered by sediment wherever they are deposited. Also, fish and other types of animals living in both fresh and salt water are buried by sediment after death. If burial is rapid, it prevents decomposition of the buried organic remains by excluding oxygen and other factors of decay.

It is easy to realize that deposits of sediments will be made of layers, such as the layers in a cake, with each layer representing a flood and the topmost layer being the youngest or representing the most recent flood.

The idea that the uppermost layer is the youngest layer is a fundamental law of nature to geologists. Geologists use the term bed or stratum (plural strata) when referring to a layer of sediment or rock.

Throughout the earth's history, sediments have been deposited by streams, ocean currents, and wind. In coastal areas, near the margins of continents, it is possible for sediments to accumulate to a thickness of thousands of feet owing to slow-sinking of the earth's crust, which permits the deposition of layer upon layer of sediment.

Many times in the earth's history, such coastal areas have been crumpled and uplifted above sea level by mountain-making forces. Mountain-making is occurring now along the shores of the Pacific Ocean in western North and South Amercia, along the east coast of Asia, and throughout the chains of islands which surround the Pacific where earthquakes and volcanoes are common. The making of mountains is not a sudden event, but occurs slowly over a period of millions of years, and it is during such times of mountain-making that sediments are hardened or solidified into rock. Uplift of the land also provides the means by which sediments containing marine (saltwater habitat) fossils are lifted thousands of feet above sea level. Thus it becomes possible to find "sea-shells" on mountain tops.

Description of Sedimentary Rocks

Sedimentary rocks consist of two main types of rock. They are: 1) fragmental, and 2) chemical, and are subdivided as follows:

Fragmental Rocks

These are rocks composed of fragments of pre-existing rocks, cement together by any one of several substances. Classification is based on the size of t fragments contained in the rock.

Conglomerate - Fragments are of pebble size, one-tenth of an inch in diameter and larger. Rock feels rough.

Sandstone - Fragments are sand size or less than one-tenth of an inch in diameter, but visible to the naked eye. Rock feels sandy.

Shale or claystone - Fragments cannot be seen with the naked eye. Feels smooth. Commonly very thin bedded.

Chemical or Nonfragmental Rocks

These are rocks which have been deposited chemically (precipitated) from solution.

Limestone - A rock usually gray or grayish-white composed of crystal of the mineral calcite. Commonly the crystals are very small and cannot be seen with the naked eye. Calcite is deposited in shallow warm seas and some fresh water lakes.

Limestone can be identified easily by amateur chemists, because a drop of weak hydrochloric acid placed on limestone will cause a bubbling or effervescence of carbon dioxide gas.

Evaporites - Rocks composed of various kinds of salt. Common table salt is very abundant in these rocks. Evaporites are deposited in bodies of water such as the Great Salt Lake in Utah. There are no known evaporites in the Hidden Valley Area.

Determining the Laws of Nature

To establish natural law, scientists follow a definite procedure and thought pattern. First, all the facts of a given situation are observed. Then thes facts are assembled, related, and explained in the most accurate manner possible The explanation is then compared with other known facts and tested with all known natural laws. Extreme caution is used, and if the explanation is proved valid afte many, many tests have been performed, the explanation then becomes a natural law such as the law on page 3 which states that the uppermost layer of rock or sed ments is the most recent or youngest layer.

The Present Is The Key To The Past

Evidences or facts such as earthquakes and volcanic activity which ar experienced frequently in some parts of the world show scientists the manner in which mountains are formed.

Signs or records in the rocks have shown geologists that mountain-making has been occurring since the earth began 3500 million years ago, in much the same way as it is occurring today. Geologists have carefully observed present day events, and have used the knowledge thus gained to interpret the events of the past. In other words, "the present is the key to the past". The success of this method has shown that the present and past are similar or uniform in nature. This uniformity is known as the "law of uniformitarianism", a law which is fundamental to science, and with which everyone should be familiar.

Stratigraphy

Definition of Stratigraphy

Many geologists devote their lives to a study of the orderly sequence of beds of rock. In other words they determine the relative age of different beds of rock and study the fossils contained in rocks. This phase of geology is known as stratigraphy (strah-tee'-grah-fee), and men who study it are called stratigraphers.

Definitions of Stratigraphic Units and Sections

Stratigraphers have shown that rocks occur in units or series of beds that have something in common such as color or rock type. For example, there may be series of beds which are red or green, a series of beds which are limestone, sandstone or shale, or a series of thin beds of alternating limestone, sandstone, and shale. Units of this sort are called formations and are named after the geographic locality at which they are first described. For example, the Bloomsburg shale was first named at Bloomsburg, Pennsylvania, and the Rose Hill shale and sandstone was named at Rose Hill, Cumberland, Maryland.

Think of a rock formation in terms of layers in a cake. A two-layer white cake would consist of one white formation consisting of two beds related by their color. A four-layer cake, with the two top layers white and the two bottom layers chocolate, would consist of a lower chocolate formation and an upper white formation. If these were layers of rocks, we could apply the age law and say that the upper or white formation was put on last and therefore is younger than the chocolate formation.

It is necessary for stratigraphers to illustrate the age and nature of rocks. To do this, they imagine a piece of cake cut from the earth's crust and draw a diagram of one side of the piece. This is called a stratigraphic section. Figure 1 is a stratigraphic section of the four-layer-cake formations.

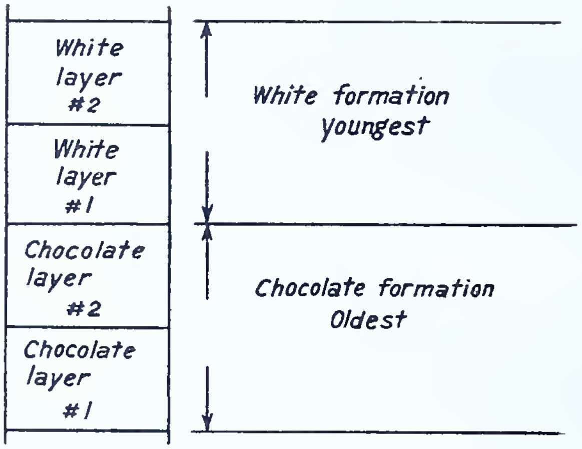


Figure 1. **Stratigraphic** section of four-**layer** cake.

GEOLOGY OF THE HIDDEN VALLEY AREA

About This Report

A geologic map (plate 2) illustrates the geology of the camp area. Each pattern of lines and dots shown on the geologic map indicates a belt of rock such as limestone or sandstone, which is the same throughout the area of each belt. For those persons interested in examining some of the rocks discussed, an appendix is included in which specific rock exposures are described. These exposures or outcrops are numbered and located on index maps in the appendix, and also on the geologic map. The significance of the station numbers assigned to the outcrop localities is explained in the introduction to the appendix (page 24), and the outcrop localities can be visited by following directions given in the appendix. In the text, occasional references are made to numbered outcrop localities where various geological principles are illustrated. The references are made either in the discussion or by inserting the station numbers in parentheses. It is possible to read the text and ignore the station references, but interested readers can refer to the appendix for additional information.

The location of unfamiliar place names such as the Loysville Road Bridge, Bowers Road, or the Unnamed Stream are shown in Figure 9. Place names not shown in Figure 9 can be found on Plate 2.

Persons wishing to know more about geology or who find this publication inadequate are strongly urged to read the Scout Merit Badge book on "Geology", which was written cooperatively by several authorities on the subject. It is a small, well-written book with many illustrations, and can be bought for twenty-five cents wherever scout supplies are sold.

Location and Geography

The Hidden Valley Boy Scout Camp is located in the southcentral part of Pennsylvania, in Tyrone Township of south-central Perry County. It is twenty-five air miles west-northwest of the center of Harrisburg, and one mile south of Loysville.

The geologic map (plate 2) shows the location of the camp relative to Loysville and Landisburg, and the accompanying index map shows the location of the geologic map within the State of Pennsylvania.

The region discussed is about seven square miles in area. It is located at the east end of Bowers Mountain, a long narrow ridge whose maximum elevation is about 2,100 feet west of the camp. The ridge elevation decreases to 900 feet south of camp and 550 feet or valley level east of camp. Bowers Mountain is flanked by a complex of low ridges and valleys on the north and Schaeffers Valley on the south, whose lowest elevations average about 550 feet.

The main camp is located along Shermans Creek which flows from distant mountainous areas west and northwest of camp, to the Susquehanna River seventeen miles to the east. Near camp, the sides of the stream valley vary from gently sloping terraces to steep valley slopes where the stream cuts into the northern slope of Bowers Mountain. It is in this area, where the valley of Shermans Creek invades the foothills of Bowers Mountain, that Hidden Valley was named.

Abundant forest land characterized by both conifer and deciduous trees surrounds the camp, thus providing abundant cover for wild life and an opportunity for scouts to observe many natural phenomena.

Stratigraphy

Introduction

The rocks of the Hidden Valley Camp area are all sedimentary rocks. They represent sediments 3,000 feet thick which were deposited during a period of 20 to 25 million years. Based on the general time scale known to geologists the sediments were deposited during the Silurian period between 375 and 350 million years ago.

The rock section of the camp area can be divided into seven units or formations. Figure 2 is a stratigraphic section similar to the cake section (page 6) which shows the youngest formation at the top.

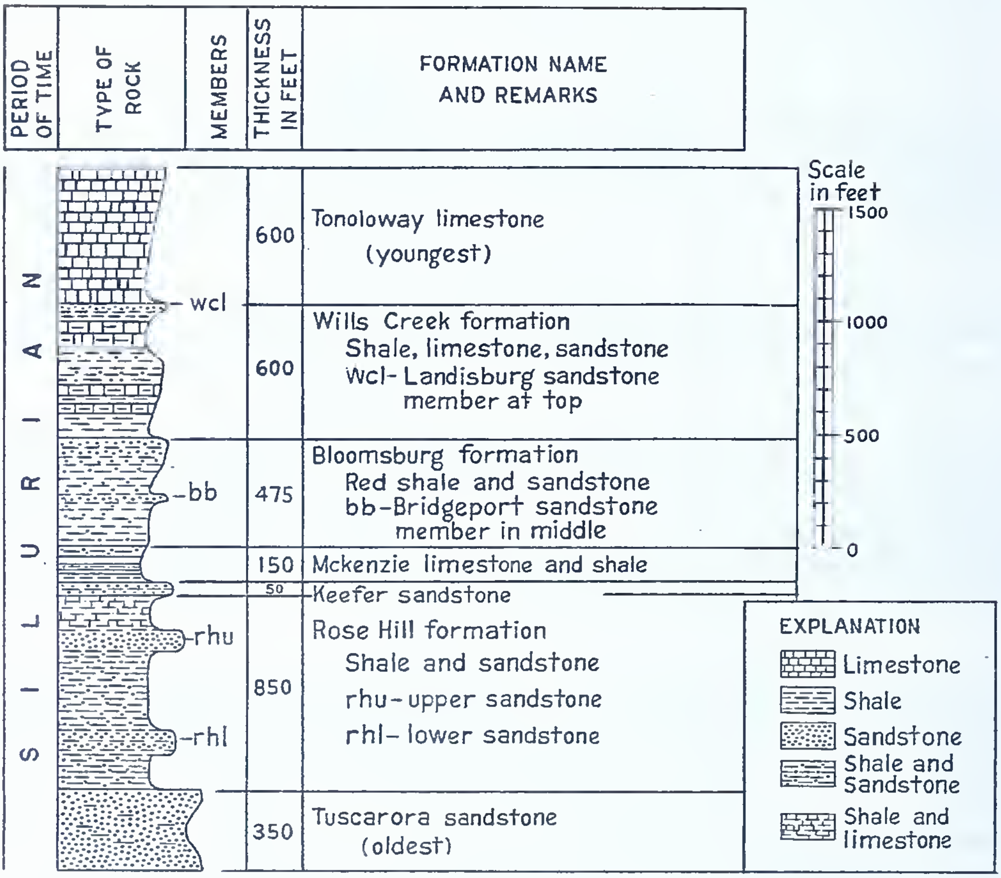


Figure 2. Stratigraphic section showing the rock formations which occur in the Hidden Valley area.

Most of the rocks in the Hidden Valley area were deposited in a marine or seawater environment. Figure 3 shows the general area in the eastern United States which was covered by seas at one time or another during Silurian time. During much of Silurian time, the seas were bordered by lowlands on the west and relative highlands on the east.

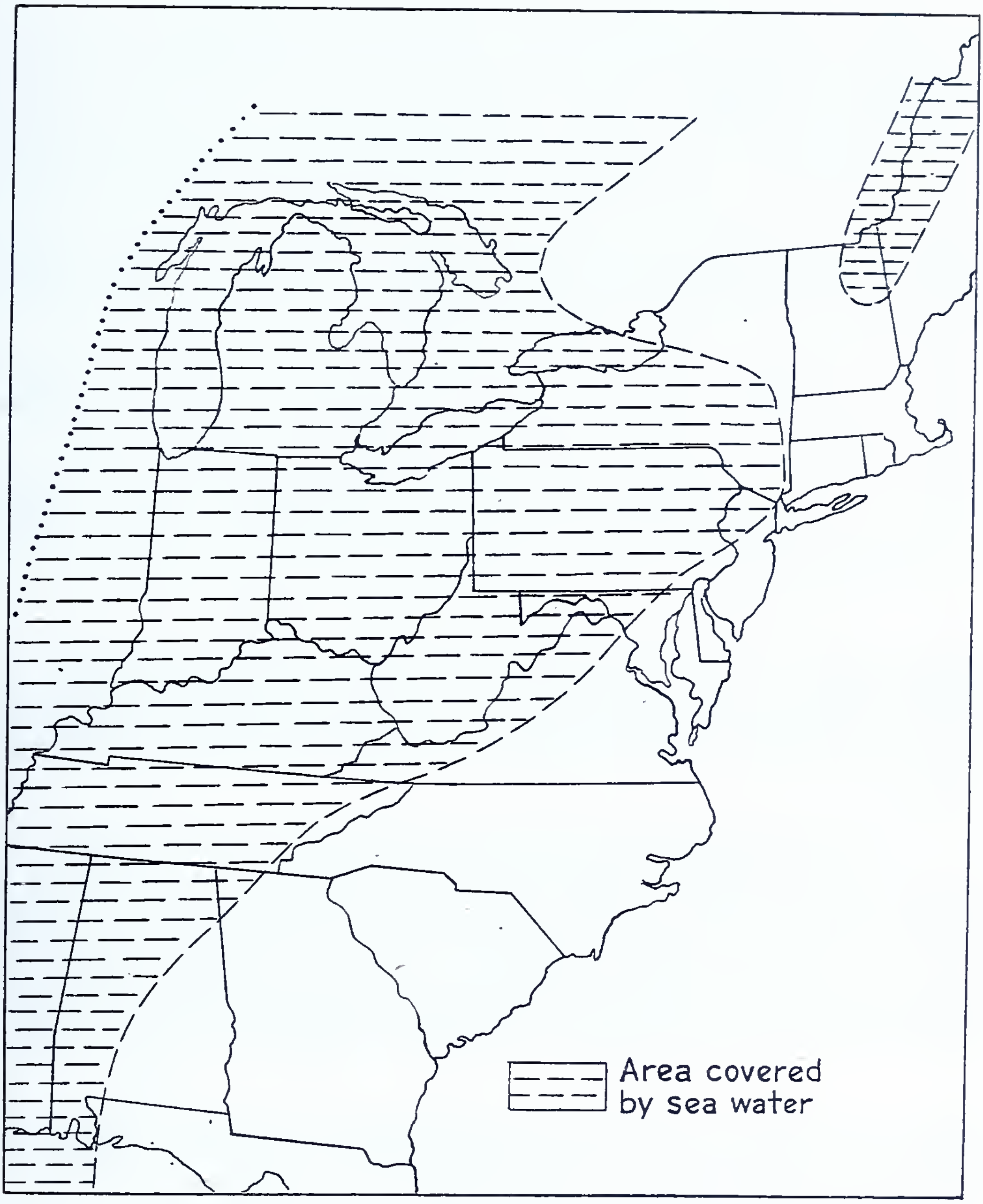


Figure 3. Generalized area covered by seawater in the eastern United States during Silurian time.

The next few pages are devoted to a description of the nature and significance of the rock formations which occur in the camp area. In the discussion, brief references are made to outcrop localities. The numbers of the figure and plate which show these localities are indicated at the beginning of each formation discussion. More detailed descriptions of these localities are present in the appendix for interested readers.

Tuscarora Sandstone

Outcrop locality - t-1 (See figure 10 and plate 2)

Name and Description The Tuscarora sandstone is the oldest formation exposed in the area. It was named at Tuscarora Mountain in northern Perry County, where the formation is well exposed. It is a hard, white to light-gray rock composed of sand grains and a minor amount of small pebbles, cemented together by the mineral quartz, which is the chemical compound silica. The formation is approximately 400 feet thick. The thickness of a formation is measured perpendicular to the bedding and is the same as the height of the white formation or the chocolate formation in the cake described on page 5.

When a piece of rock is chipped from a Tuscarora boulder the color of the freshly broken surface is whitish gray. However, the outer surface of the rock is a darker or medium gray. The darker outer color is due to weathering which results from chemical decomposition, caused by things such as rain water, oxygen, and organic acids. Thus the color of the outer surface of boulders is referred to as the weathered surface and often differs from the color of a fresh unweathered surface.

The Tuscarora sandstone is found at the tops or crests of most of the highest ridges of Perry County. Similarly it is found on the high part of Bowers Mountain west of camp at locality #t-1. Its occurrence high on the ridges is evidence that it is hard and resistant to weathering. Thus one can infer that it is not worn down by erosion as rapidly as the rocks in the valleys on both sides of the mountain.

One fact which illustrates the power of erosion is that loose boulders of Tuscarora sandstone are commonly found in valley bottoms. Usually the closest outcrop of Tuscarora sandstone which can be found is high on a nearby ridge. Thus one must explain how the boulders move from the original outcrop high on the ridge to the valley bottom. The answer is that they are moved by stream erosion and the pull of gravity which causes rock slides and aids streams in slowly rolling boulders down hill, especially during times of flood.

Uses The Tuscarora sandstone is commonly referred to as "ganister rock", a commercial name for rock which is quarried and made into bricks used to line the inner wall of iron furnaces. It is also used as glass sands from which glass products are made, and as building stone.

Rose Hill Formation

Outcrop localities - rhu-1 to rhl-14 (See figure 11 and plate 2)

Name and Thickness The Rose Hill formation is named for a locality on Rose Hill Cumberland, Maryland and can be traced continuously along many ridges from Maryland to Perry County. In the Hidden Valley area the formation is about 850 feet thick, and underlies most of the camp area.

Relation to Topography West of camp, the whitish Tuscarora sandstone underlies the crest of Bowers Mountain and the Rose Hill formation makes two series of spurs or small ridges on the northwest side of the mountain and a smaller terrace-like ridge on the southeast side of the mountain. On the geologic map (plate 2) it can be seen that from west to east, the Rose Hill ridges join and form a single ridge which becomes lower and lower until the ridge dies out one mile east of camp.

Description The Rose Hill formation consists of both sandstone and shale beds of several colors. There are two zones of sandstone, one in the upper half and the other in the lower half of the formation. The remainder of the formation is mainly shale interbedded with a few thin sandstone beds. The beds vary in thickness from a maximum of 2 to 3 feet in the sandstone to a fraction of an inch thick in the shales.

The Rose Hill sandstones can be recognized easily owing to their purple or grayish-red color and massive outcrops as seen in the camp area at locality rhu-6. The color in these rocks is due to hematite, a dark-red iron mineral which occurs as a coating on the sand grains and as a cementing material between the grains.

The shales of the Rose Hill formation are not often well exposed. However, some shale can be seen associated with the sandstones at most of the Rose Hill localities described in the appendix. The shales are easily recognized by their pale-yellow and olive-green color where they are associated with the grayish-red sandstones.

The grayish red of the sandstones is only slightly altered to a darker color by weathering. However the shales, when fresh, are various shades of olive gray, pink, and medium gray, and commonly weather to pale yellow and yellowish brown. The weathered shale can be seen along stream banks, or in debris at the base of fallen trees, or piled at the entrance of woodchuck holes. The sandstone is more resistant to weathering than the shale, and covers the slopes of small ridges where erosion is slowly moving plate-like fragments and smaller pieces down into the valleys.

Historical Clues One feature of sedimentary rocks well exhibited by the Rose Hill sandstone beds is called cross-lamination or cross-bedding. These are thin laminae or beds which make a 30 or 35 degree angle with the main bedding as one looks at a cross section of a bed. Cross-lamination is caused by stream currents during the time of deposition. Figure 4 shows the top and two sides of a bed which illustrates cross-lamination.

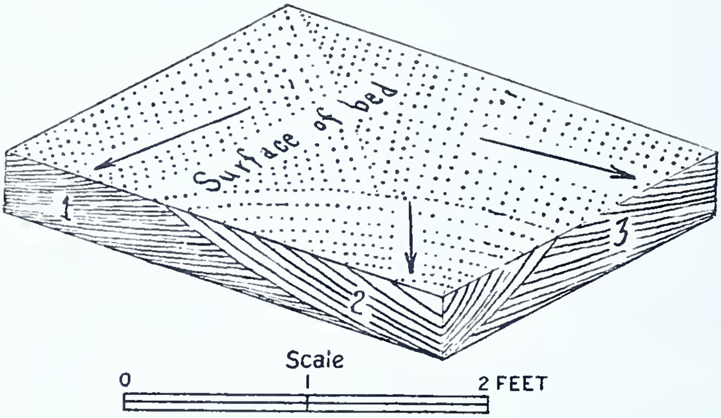


Figure 4. Block diagram showing sets of cross-laminae (1,2,3), as they appear on the sides of a bed, and the directions (arrows) of current flow which formed them.

The direction of the current which causes cross-lamination can be determined, and is the direction in which the cross-laminae dip or tilt on the side of the bed. Good examples of cross-lamination can be seen at rhu-6 and 8 and also at most of the other outcrops of the grayish-red sandstones.

Some bedding surfaces of the Rose Hill sandstones are very irregular rather than being smooth like the cover of a book. Some of the irregularities are thought to be the fossilized burrows of worms which lived during the time of deposition; however most of the irregularities are called ripple marks, (figure 5) another feature caused by water currents. Ripple marks are seen commonly in sandy deposits along present day beaches and streams

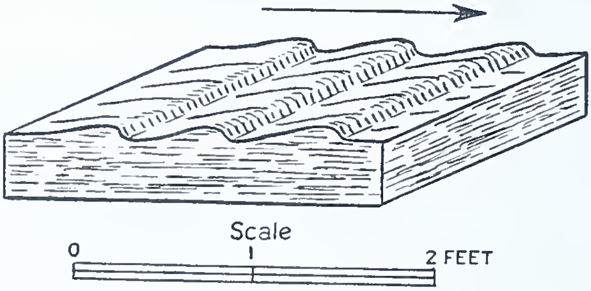


Figure 5. Block diagram showing ripple marks on the surface of a bed, and the direction (arrow) of current which caused them.

Fossils In some places fossils are abundant in the Rose Hill formation. The remains of various types of shelled sea animals can be found in the shales and in the thin one-inch to six-inch beds of sandstone interbedded with the shales.

History The Rose Hill formation was deposited during a time characterized by seas of moderate to shallow depth. The thick sandstones represent times when the sea was probably shallower than during the periods of shale deposition. The iron minerals in the sandstones imply that during the time of sandstone deposition, the adjacent coast line was low, swampy, and not disturbed by mountain-making.

Uses Locally, the Rose Hill shales are used for road fill. Some large borrow pits are operated from time to time in Perry County, although there are none within the camp area.

In the eighteen hundreds iron ore was mined from one or two horizons in the Rose Hill formation along Tuscarora Mountain several miles north of camp, but these deposits can no longer be mined at a profit.

Keefer Sandstone - McKenzie Limestone and Shale

Outcrop localities: k-1 to k-8 (See figure 12 and plate 2)
and m-1 to m-3 (See figure 13 and plate 2)

Name and Thickness The Keefer sandstone and McKenzie beds were named for localities in Maryland and can be traced to the Perry County area. The Keefer sandstone is 40 to 50 feet thick and the McKenzie limestone and shale is about 150 feet thick. They can both be distinguished in good exposures along streams and road-cuts, but are mapped as one unit since their combined thickness is only 200 feet.

Relation to Topography In the topography, the Keefer makes a small ridge and the overlying McKenzie makes a narrow valley. These two features can be seen in camp. The Keefer is present on the northeast side of Shermans Creek at k-4 and can be traced northeast up the stream bank, under Rotary Lodge and on up the hill to an exposure in a small borrow pit, where the camp is currently obtaining rock fill.

The McKenzie unit parallels the Keefer outcrop and makes a narrow, shallow valley on the northeast side of Shermans Creek at m-1, northwest of Rotary Lodge.

These same two units can be traced southwest across camp to k-5 and m-2, past the south end of the swimming pool in the main camp area.

Description The Keefer sandstone is dark medium gray to brownish and whitish gray on fresh surfaces, and light gray on weathered surfaces. The grain size varies from sand to small pebbles. There are three sandstone horizons each several feet thick interbedded with dark-gray shale and very fine-grained sandstone.

Some iron minerals are found in the lower and upper parts of the sandstone. The one most commonly found is pyrite, which is often called "fool's gold" due to its golden yellow color. When found, it is an attractive collectors item, but is not of commercial value except under special circumstances.

The McKenzie unit consists mostly of beds from one to six inches thick of dark-gray limestone which weathers dark brown, interbedded with medium- to dark-gray, thin-bedded shale, some of which is calcareous or limy.

The best known outcrop of the Keefer-McKenzie formation is exposed in a small stream valley at the k-7 locality.

History The Keefer-McKenzie formation contains marine, salt-water fossils which indicate that the formation was deposited in a sea environment. The sand is probably a near-shore deposit, and the overlying shale and limestone represent deposition in quieter waters, possibly deeper and farther from shore.

Uses Currently the Keefer-McKenzie formation has no commercial value except for occasional use as road fill, although in the eighteen hundreds a minor amount of iron was mined from the Keefer sandstone.

Bloomsburg Formation

Outcrop localities: bb-1 to bb-9 (See figure 15 and plate 2)

Name and Thickness This formation was named at Bloomsburg, Pennsylvania, where it was first described. In the Hidden Valley area it is about 475 feet thick.

Relation to Topography The Bloomsburg formation in Perry County crops out along the base of all the high ridges such as Bowers Mountain. In the foothills, it forms the upslope limit of agricultural and pasture land and in many places is covered with forest growth.

Description Color is the most characteristic feature of the Bloomsburg formation It is dark brownish-red and can be seen exposed in a cliff face by looking northwest along Shermans Creek from the Vehicle Bridge in the Main Camp area.

The Bloomsburg rock types vary from shale to sandstone, all of which are red, except for a light-gray sandstone and conglomerate 5 to 15 feet thick in the middle of the formation. This sandstone is called the Bridgeport sandstone member of the Bloomsburg formation. The Bloomsburg red beds retain a red color even when weathered to soil.

In the Loysville area, a few small fossils have been found in the Bloom burg red beds, some being small fragments of primitive fish. However, there are no known fossil localities in the Bloomsburg beds of the Hidden Valley area.

History The Bloomsburg formation is thought to have been deposited by rivers and streams in the shallow, brackish (slightly salty) marine water of a coastal area. The fish remains found are from fish which probably lived in nearby, fresh or brackish water and were transported to the Hidden Valley area by streams and currents flowing from the east and southeast.

Bloomsburg-type deposits are characteristic of river deltas similar to the Mississippi River delta now being deposited along the Gulf Coast. Thus, the seas in which the Rose Hill-Keefer-McKenzie marine formations were deposited must have been made shallow by uplifting of the land or lowering of the sea until the Hidden Valley area became intermittently dry land, very close to sea-level, along a vast coast line that stretched from New York to Maryland and probably farther south.

Uses The Bloomsburg is used for road fill, and although cultivated to some extent, is best for pasture land. It has no other local commercial value.

Wills Creek Formation

Outcrop locality: wc-1 (See figure 16 and plate 2)

Name and Thickness The Wills Creek formation was named at a creek near Cumberland, Maryland, and can be traced to the Perry County area. At Hidden Valley, the formation is about 600 feet thick.

Relation to Topography The formation crops out in, and underlies, the major valleys or lowlands of Perry County. Near Hidden Valley it occurs in the broad valleys north and south of Bowers Mountain, and although it does not underlie any part of the camp area, it is included in the report because it is of interest. It is easily recognized as two distinct parallel ridges, each ridge representing half of the formation.

Description The Wills Creek formation is commonly called a shale, but near Hidden Valley consists of interbedded shale, limestone, and minor sandstone. The Landisburg sandstone member, 10 to 20 feet thick, is present at the top of the formation and underlies several small ridges in the cultivated area north and east of the camp area.

There are several rock colors present. The lower half of the formation is interbedded red and pale-green shale and very fine-grained sandstone which can be seen at locality wc-1. The upper half of the formation is dominantly medium gray and variable from shale to impure limestone, the main exception being the red Landisburg sandstone member at the top.

The color of the rocks does not change much with weathering, except for the impure, gray limestones and pale-green shales which weather to a pale yellowish brown or yellowish gray.

Fossils There are many fossils present in the Wills Creek formation, but only two or three different types. A small, shelled animal with a pair of shells like a clam makes up 90 percent of the fossils. The shells are bean-shaped and found in various sizes ranging from the size of a lima bean to the size of a pinhead. These animals are called ostracods.

Other fossils present are small sea shells (brachiopods) about one-half inch long, and snail shells one-fourth to one-half inch long.

In the Landisburg sandstone member, at the top of the formation, fragments of primitive fish are found, although lack of good exposures near camp prevents good fossil collecting.

History During deposition of the Wills Creek sediments, the Hidden Valley area was very close to sea level and while the lower half of the formation was being deposited the land surface probably oscillated up and down alternately slightly above and below sea level. During deposition of the limestone in the upper half of the formation, the area was mostly beneath sea level.

While Wills Creek sediments were accumulating in the Hidden Valley area, thick salt deposits were being deposited in inland sea basins over much of western Pennsylvania, south-central and western New York, and a greater area to the west. Perry County was marginal to the salt basins, and was characterized by less salty, shallow seas.

Uses The Wills Creek formation underlies much of the fertile farm land in Perry County and thus its chief use is agricultural. The banded yellowish and reddish weathered color of the shales is easily noted in the soil of many fields.

Tonoloway Limestone

Outcrop locality: to-1 (See figure 16 and plate 2)

Name and Thickness The Tonoloway limestone was named at a ridge in Maryland. The formation can be traced from Maryland to the Hidden Valley area where it is about 600 feet thick.

Relation to Topography The Tonoloway limestone, similar to the Wills Creek formation, underlies the major valleys or cultivated areas.

Description The formation is mostly medium-gray, impure limestone and limy shale. Thus it resembles the rocks of the upper Wills Creek. However, there is more limestone in the Tonoloway than in the Wills Creek formation. The limestone in the Tonoloway formation weathers readily, and as a result outcrops are few compared to other formations.

Fossils Fossils present in the Tonoloway include ostracods, small bean-shaped fossils similar to those present in the Wills Creek formation, plus other small marine shells.

History The marine fossils and other features in the Tonoloway indicate that the sediments were deposited in a shallow sea. West and north of Perry County, the period of salt deposition continued through Tonoloway time.

Uses The Tonoloway limestone has been quarried in many places in Perry County. The material has been used extensively for crushed rock and in the past, many farmers have burned the limestone to obtain lime, which they use as a soil conditioner.

Geologic History

The picture presented by the sequence of formations begins with deposition of the sand found in the Tuscarora sandstone. At that time the Hidden Valley area was probably under sea but near the shoreline. During deposition of the Rose Hill, and Keefer-McKenzie formations, the water became deeper. Clay, silt, and lime muds were deposited and marine animals were common, as shown by the presence of marine fossils. The water became shallow at least twice and sand mixed with iron rich clay was deposited.

Early during deposition of the Bloomsburg, Wills Creek and Tonoloway formations, the sea became very shallow and occasionally the Hidden Valley area was exposed as dry land, but again the water gradually deepened and limestone muds were deposited, while to the northwest in New York and western Pennsylvania, salt was being deposited in an inland, landlocked sea.

The rocks in nearby areas which are younger than the Tonoloway limestone indicate that the Hidden Valley area was alternately exposed and covered by seawater several times after deposition of the Tonoloway lime muds, during a period of millions of years. Finally about 200 million years ago, a period of mountain making occurred which exposed the Hidden Valley area as dry land and folded the sediments into a series of troughs and ridges which trend northeast. Geologists believe that the area has remained as dry land from the period of mountain making until the present day.

Structural Geology

It has been shown thus far in this discussion that sedimentary rocks consist of layers or beds. When sediments are deposited the layers are nearly horizontal, but if a period of mountain-making then occurs, the beds are commonly crinkled or folded (see figure 6), and broken or faulted (see figure 7). Where the rocks are folded, the up-folds or ridges are called anticlines and the down-folds or troughs are called synclines.

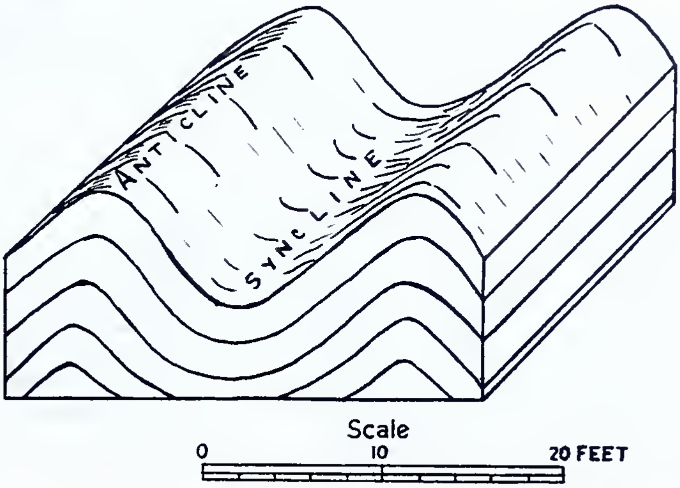


Figure 6. Block diagram showing folded beds of rock.

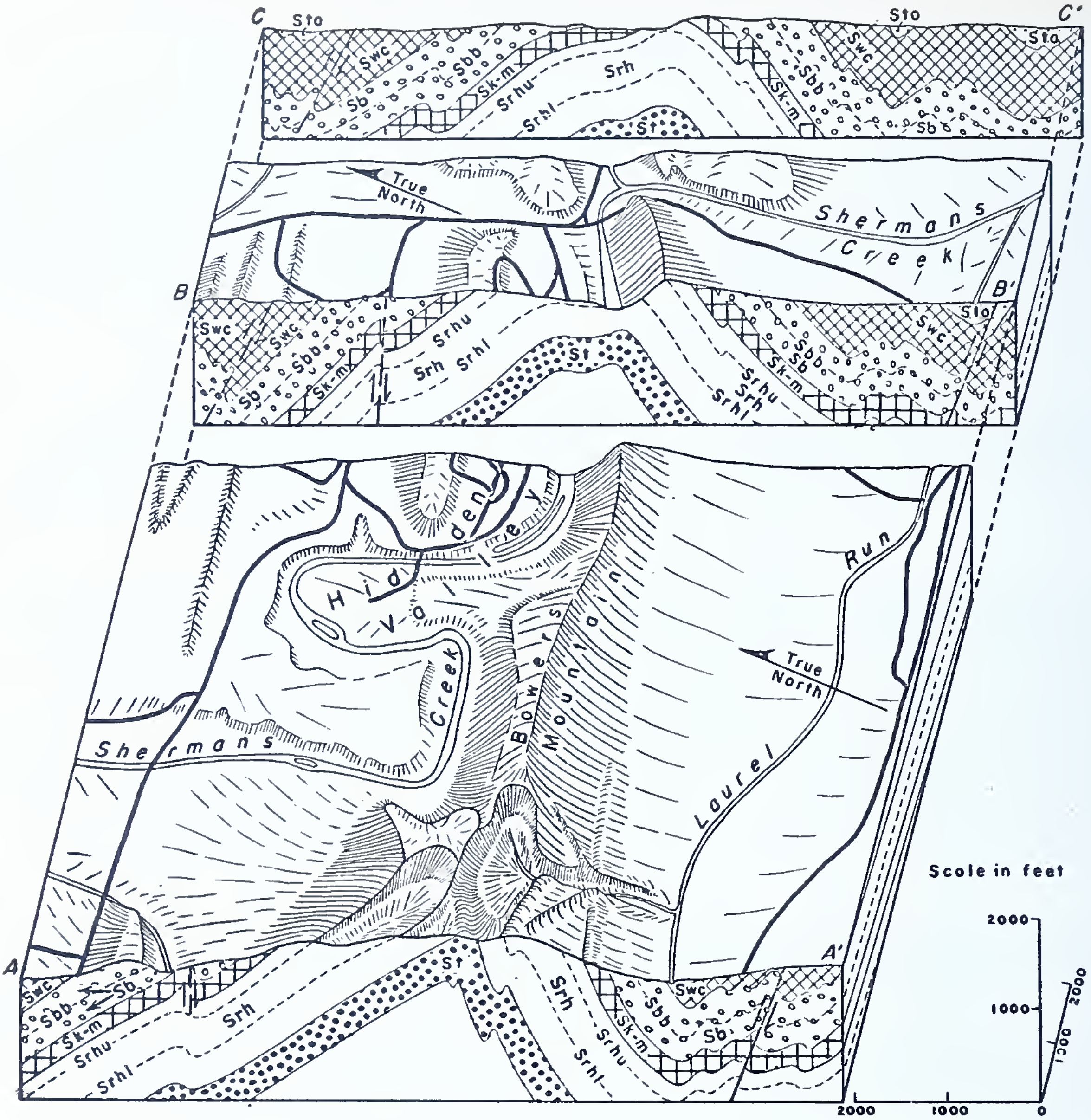


PLATE 1. Block diagram of the Hidden Valley area, illustrating the relationship between rock structures and topographic features. The locations of cross sections AA', BB', and CC' are indicated by lines on the geologic map

EXPLANATION

Sto	Tonoloway limestone
Swc	Wills Creek shale, limestone, and sandstone
Sbb	Bloomsburg redbeds; Sbb, Bridgeport sandstone member
Sk-m	Keefer sandstone through Mckenzie shale and limestone
Srh	Rose Hill shale and sandstone; Srhu, upper massive sandstone member, Srhl lower sandstone member.
St	Tuscarora sandstone
↿⇂ ↿⇂	Faults showing relative displacement

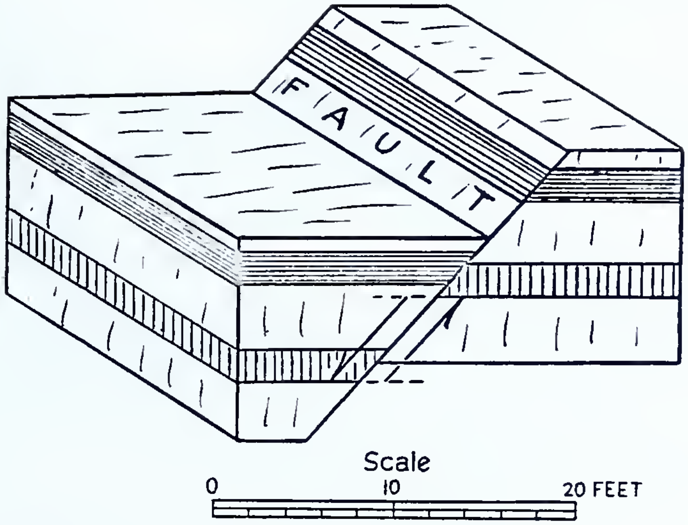


Figure 7. Block diagram showing faulted beds of rock. Arrows show relative movement of the two blocks.

When layers or beds of rocks are deformed by folding and faulting, the process is called deformation. The study of the deformation of rocks is called structural geology. In some areas, rocks have not been deformed much by mountain-making and thus a flat layer-cake arrangement is maintained. This is true of western Pennsylvania, but in central Pennsylvania the rocks were folded and faulted during a long period of mountain-making which occurred about 200 to 250 million years ago. At that time the whole chain of the Appalachian Mountains including the Hidden Valley area was uplifted above sea level by forces acting in the earth's crust. Since that time erosion has been gradually wearing away the mountains. Several gentle uplifts have occurred since the main period of mountain-making and an approximate total of five vertical miles of rock has been removed by erosion. In the future, erosion will continue to wear down the mountains, but the process is a slow one.

Method of Observing Structure

Before describing the structure of Bowers Mountain, it is necessary to know the sort of observations made by geologists to determine the type of structural features present in an area.

Where beds of rock are not tilted, it is easy to describe their structure by saying they are horizontal. However, where rocks are folded as in figure 6, the rocks are tilted and the tilt must be described in definite terms. To describe the tilt, geologists use two terms which are strike, and dip. Figure 8 shows an outcrop of a bed which is tilted.

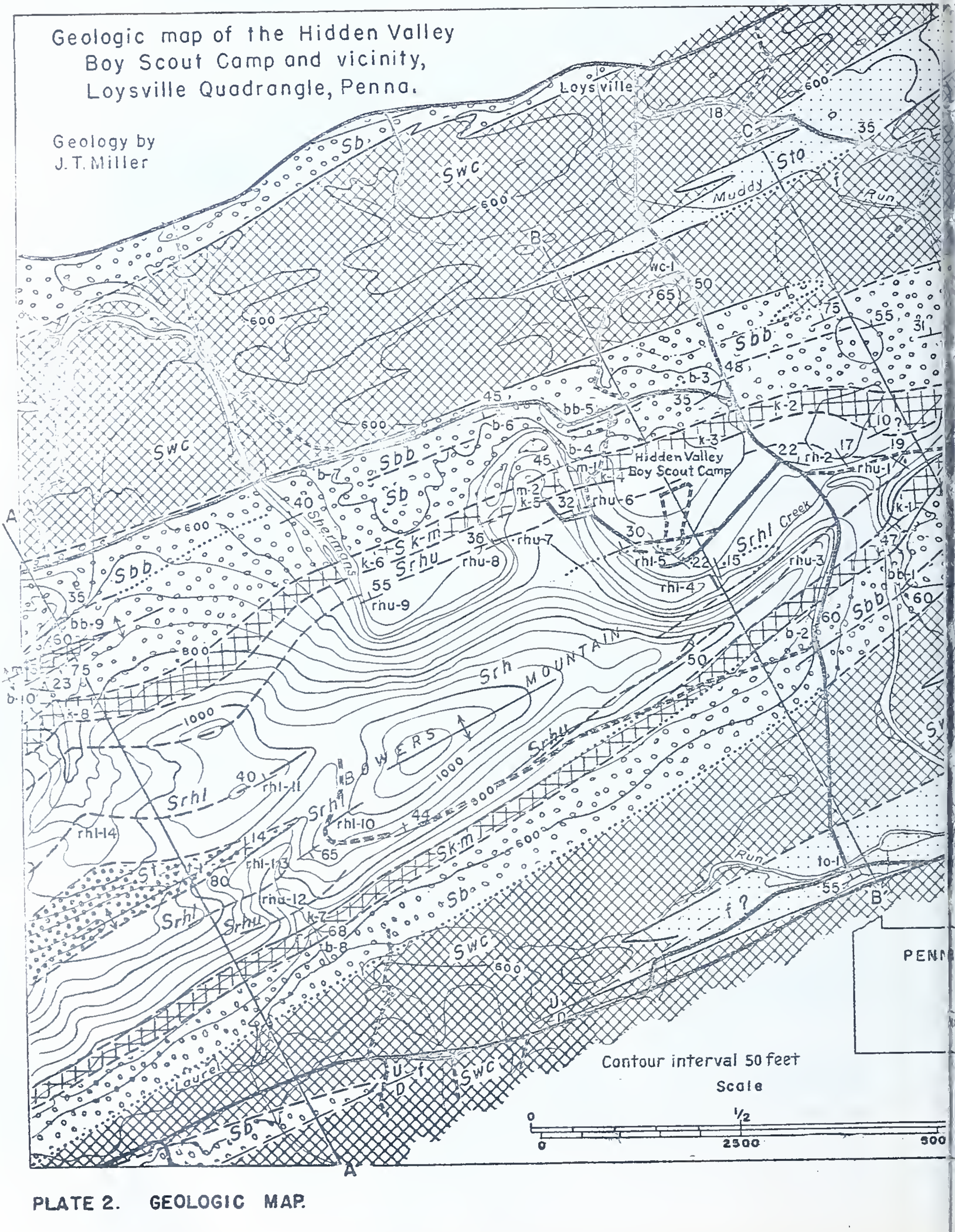
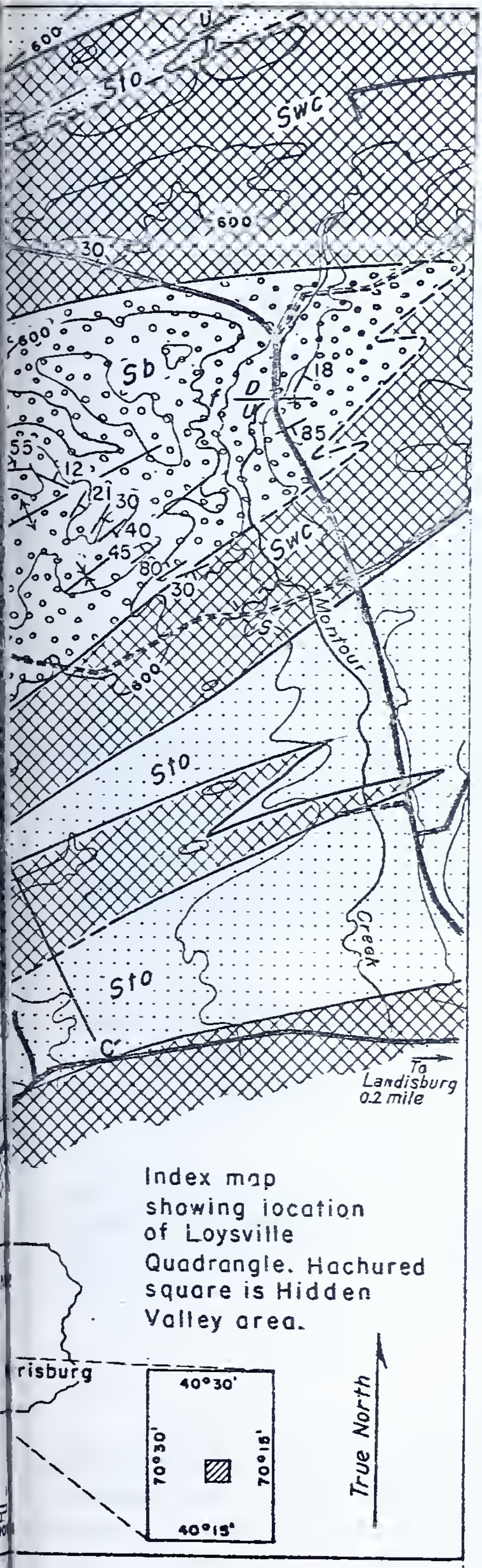


PLATE 2. GEOLOGIC MAP.



Index map showing location of Loysville Quadrangle. Hachured square is Hidden Valley area.

EXPLANATION

ROCK FORMATIONS

Sto	TONOLOWAY LIMESTONE & CALCAREOUS SHALE. to-1 - STATION DESCRIBED IN APPENDIX.
Swc	WILLS CREEK SHALE, SILTSTONE & ARGILLACEOUS LIMESTONE. wc-1 - STATION DESCRIBED IN APPENDIX.
Sb	BLOOMSBURG RED SHALE AND SILTSTONE. Sbb-BRIDGEPORT SANDSTONE MEMBER. b-1, bb-2 - STATIONS DESCRIBED IN APPENDIX.
Skm	KEEFER SANDSTONE AND McKENZIE LIMESTONE AND SHALE. k-1, m-1 - STATIONS DESCRIBED IN APPENDIX.
Srh	ROSE HILL SHALE AND SANDSTONE. Srhu-UPPER SANDSTONE MEMBER, Srhl-LOWER SANDSTONE MEMBER, rhu-1, rh-2 AND rhl-4 - STATIONS DESCRIBED IN APPENDIX.
St	TUSCARORA SANDSTONE. t-1 - STATION DESCRIBED IN APPENDIX.

STRUCTURAL DATA

STRIKE AND DIP OF BEDS.

⊥45	BEDS RIGHT SIDE UP, DIP 45°
∼∼	GENERAL TREND OF CONTORTED BEDS.
∼S	GENERAL TREND OF CONTORTED FOLDED BEDS. *S* INDICATES FLANK WITH STEEPEST DIP.
↕	AXIS OF ANTICLINE.
✕	AXIS OF SYNCLINE.
f — U/D	FAULT; "*U*" IS UPTHROWN SIDE, "*D*" IS DOWNTHROWN SIDE.
A——A'	LINE OF CROSS SECTION ILLUSTRATED IN TEXT.

ROCK FORMATION CONTACTS

——	CONTACTS TRACEABLE IN FIELD OR ON AERIAL PHOTOGRAPH.
— — —	CONTACTS FAIRLY TRACEABLE OR TRANSITIONAL CONTACTS.
• • • • • •	CONTACTS UNCERTAIN DUE TO STRUCTURAL COMPLEXITY, TRANSITIONAL NATURE OF STRATA, OR ALLUVIAL COVER.

CULTURE

——	ROADS
∼∼	STREAMS
—1000—	ELEVATION CONTOURS
CONTOUR INTERVAL	-200 FT.

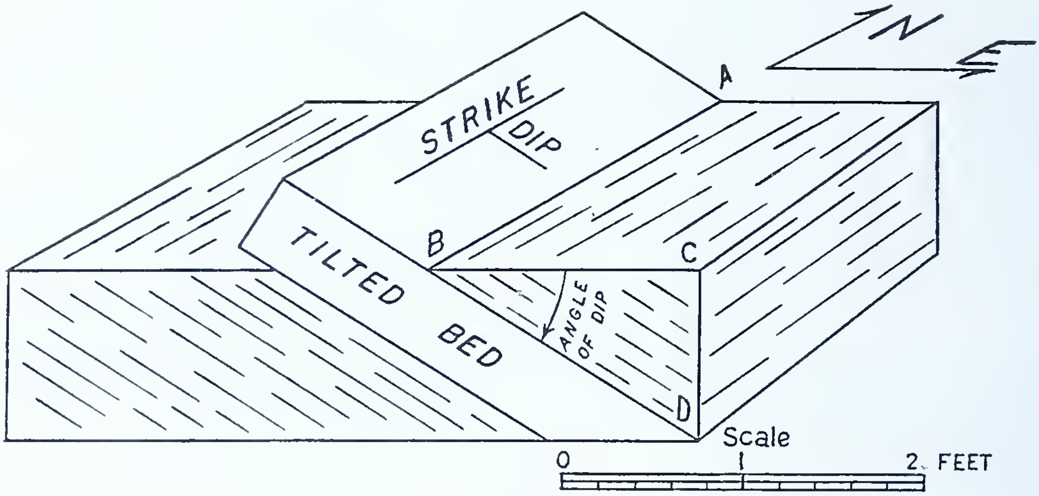
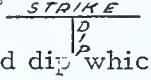


Figure 8. Block diagram illustrating strike and dip.

The top of the block shown in figure 8 represents a horizontal or level surface of the earth. Where the top of the tilted bed and the horizontal earth's surface meet, a horizontal line is formed as between the letters A and B on the figure. The horizontal line described points north. Thus, the bed is said to strike north, which means any horizontal line drawn on the surface of the bed will point north. It also points south, but only the north direction is necessary to describe the strike of a bed.

The dip or tilt of the bed is measured in the direction which makes a right angle (90°) with the strike line, and is the angle between a horizontal plane (in this case the earth's surface) and the surface of the bed. In figure 8, the angle of dip is the angle between the lines BC and BD.

The directions of strike and dip on the figure are represented by the symbol ⊤ on the surface of the bed. The long line shows the direction of strike and the short line shows the direction of dip . This is the symbol used on geologic maps to indicate the strike and dip which may be referred to as the attitude of the beds.

Hidden Valley Structure

The rocks of the Hidden Valley area are folded and also slightly faulted Plate 1 shows the nature of the folds. One can picture best the features shown on plate 1 by imagining that he is looking northeast at the camp area from a helicopter hovering over Bowers Mountain two miles southeast of camp. The camp area is shown in plate 1 as a large, nearly square piece of cake that has been lifted and suspended in mid-air. The cake has been cut into a large and small piece. The topography and roads are sketched on top of the cake and the folds in the rocks (anticlines and synclines) are drawn as three cross-sections which show the front, middle, and rear sides of the cake. The locations of the cross-sections are indicated on the geologic map (plate 2) by the lines AA', BB', and CC'.

Note that Bowers Mountain is an anticline and the valleys north and south of the mountain are synclines. The bottom or trough-line of the syncline south of the mountain occurs approximately along Laurel Run on section AA'.

The ridges are underlain by the resistant sandstones such as the Tuscarora and parts of the Rose Hill formations, and the valleys are underlain by less resistant, more easily eroded shale and limestone such as the Wills Creek and Tonoloway formations. On the geologic map (plate 2) the pattern of the belts of rocks shows that one can walk around the east end of Bowers Mountain, staying at all times on rocks of the Rose Hill formation. In doing so, the direction of the dip changes from 35 degrees northwest on the north side of the mountain, to a gentle northeast dip at the end of the mountain, to 70 degrees southeast on the south side of the mountain. The change in dip from the north to the south side of the mountain is the evidence which shows geologists that Bowers Mountain is an anticline.

Note that in section AA', the top of the Tuscarora formation is present at the earth's surface. However, at section CC', northeast of AA', the top of the same formation is almost 1000 feet below the present surface of the earth. Thus the folded rocks plunge beneath the earth's surface in a northeast direction. For the same reason, Bowers Mountain plunges from a high ridge southwest of camp to a very small ridge northeast of camp where the Tuscarora formation is not present at the surface. Thus, one might call the northeast end of the mountain the point or nose of an anticline in the Tuscarora and Rose Hill formations.

APPENDIX
OF
OUTCROP LOCALITIES

Introduction

Bedrock is exposed as ledges both large and small along stream valleys and on the mountain slopes in the camp area. In the locality descriptions which follow, many of the major outcrops in the camp area are described briefly for the benefit of those who wish to examine various rock formations in the field.

In referring to station localities, pertinent distances are given in thousands of feet. Thus, anyone wishing to visit the stations can locate them by measuring his pace or the distance covered by two steps, and then determining distance while walking by counting paces, or every other step. Compass directions stated as northwest or northeast are general directions unless stated specifically as in north 30 degrees west.

The localities for each formation are described in groups and numbered consecutively from east to west. They can be located by first finding them on one of the index maps (figures 10 to 13, and 15 and 16), which accompanies the locality descriptions of each formation, and then finding the corresponding locality symbols on the geologic map. For example, localities where the Bloomsburg formation is well exposed are listed as stations bb-1, b-2, b-3, b-4, etc. These symbols can be found on the geologic map within the area underlain by the Bloomsburg formation, which is indicated on the map by a pattern of small circles and the symbol Sb. In the appendix, these stations are located verbally by referring to prominent features shown on the map. The scale of the map is indicated in the map explanation and a small six-inch ruler can be used to determine distances. To avoid cluttering the geologic map, names such as the Loysville Road, Landisburg Road, the Unnamed Stream, etc., used in locating stations are shown on the index map in figure 9.

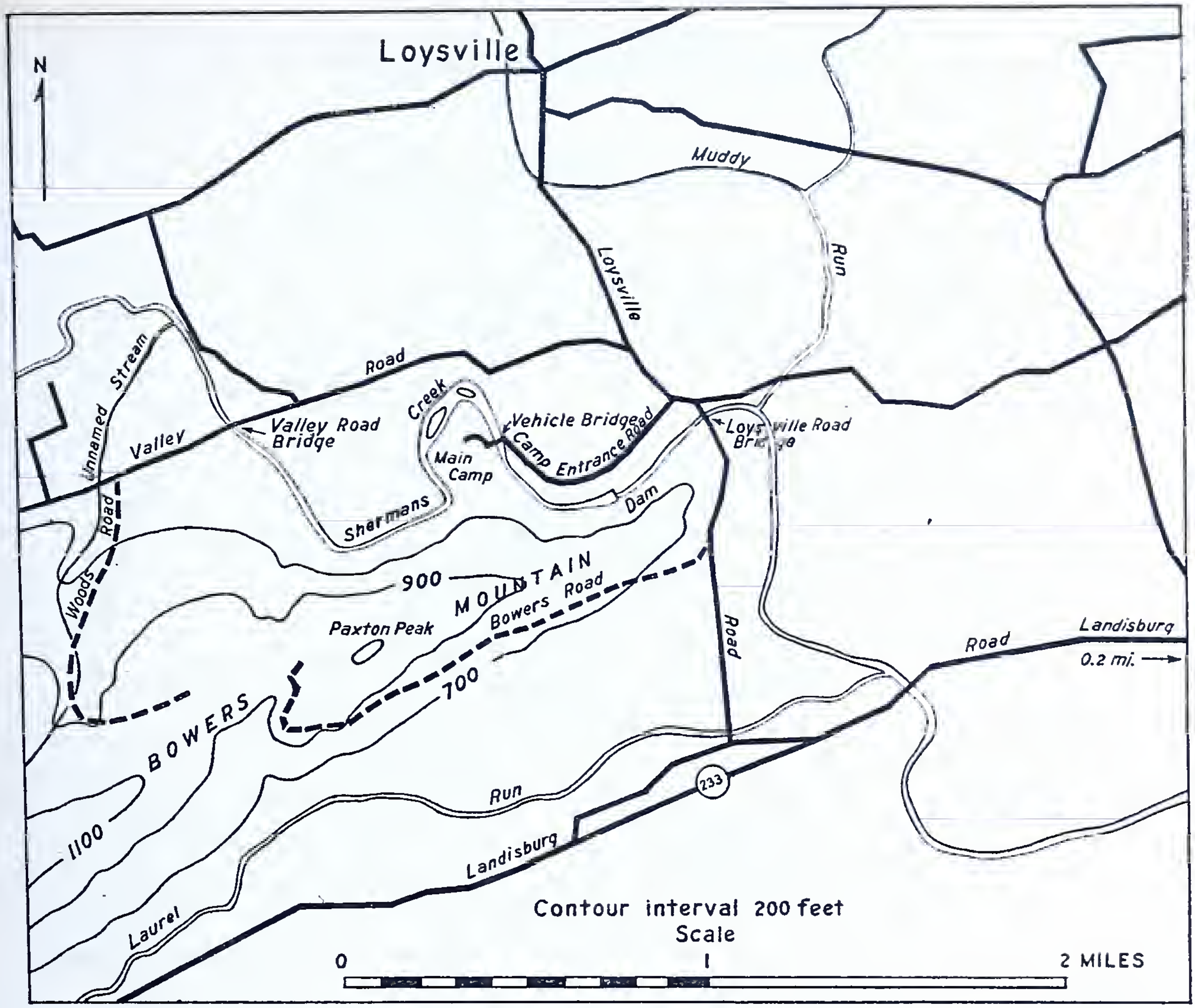


Figure 9. Index map of place names used in the appendix.

Tuscarora Sandstone

(Formation description on page 10)

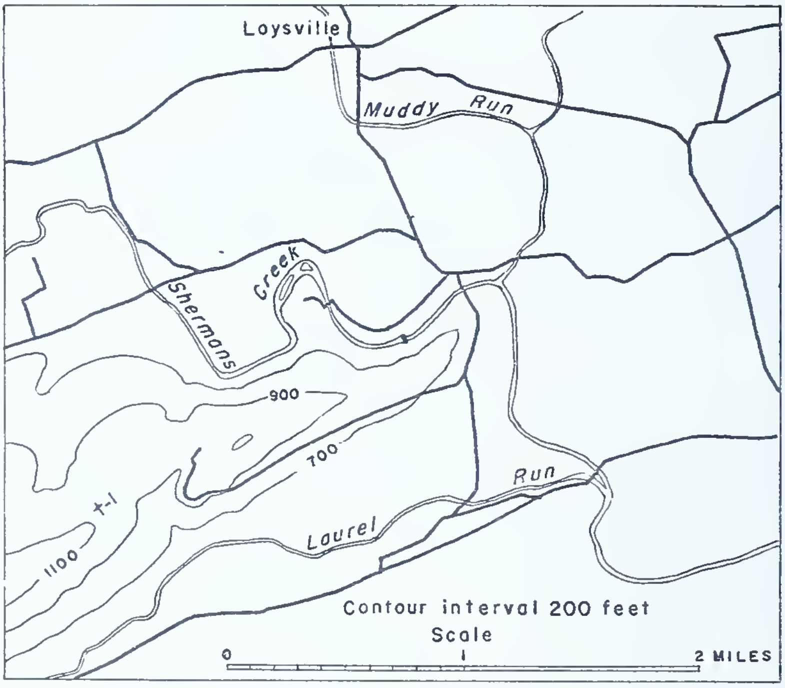


Figure 10. Location (t-1) of outcrop of Tuscarora sandstone.

t-1 This locality is easily recognized by the presence of large boulders of whitish gray to light-gray Tuscarora sandstone along the mountain top. The boulders have been moved only slightly by erosion and thus represent bedrock.

The attitude of the beds is not apparent, but the dip is gentle toward the northeast, this being the crest of the Bowers Mountain anticline. The beds can be traced a quarter of a mile northeast along a trend parallel to and about 140 feet south of the edge of a pine forest beyond which the Rose Hill covers the Tuscarora formation (see geologic map).

This is the only known occurrence of the Tuscarora formation in the Scout Camp area.

Rose Hill Formation
(Formation descriptions on page 10)

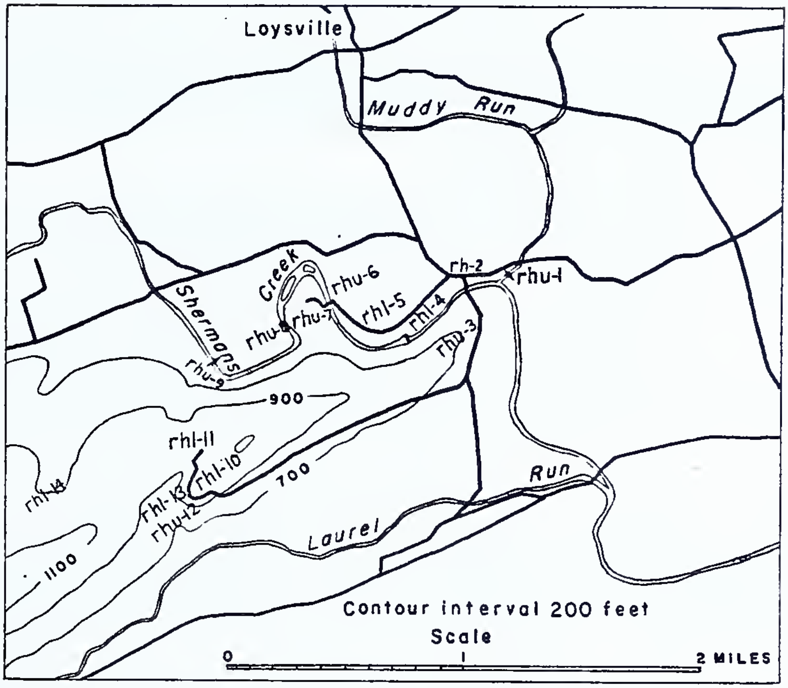


Figure 11. Locations(rhu-1 to rhl-14) of outcrops of Rose Hill formation.

hu-1 This station is located at a small wooden shanty on the west side of Muddy Run, on the south side of a dirt road which trends east from the Loysville Road.

The outcrop consists of purplish or grayish red beds of the massive upper sandstone in the Rose Hill formation. The average strike is north 23 degrees west and dip is 20 degrees northeast. The outcrop at this station can be traced west to stations rhu 6, 7, 8, and 9.

h-2 Station rh-2 is the rock exposed in the road bank along the east side of the Loysville Road, half-way between the Camp Entrance Road and the Loysville Road Bridge.

The outcrop consists of interbedded thin to medium beds of greenish-gray to olive-gray shale and fine-grained sandstone, which occur between the Rose Hill upper and lower sandstones. The average strike is north 80 degrees west and the dip is 22 degrees northeast. The sandstone beds are broken into rectangular blocks by nearly vertical cracks or fractures which are called joints. There are two main directions of jointing the strikes of which average north 45 degrees west and north 42 degrees east.

Some of the sandstone beds contain small marine fossils. The cente of many of the sandstone blocks are weathered and somewhat crumbly when broke but are difficult to break due to a thin hard shell of red, iron minerals.

rhu-3 On the south side of Shermans Creek, west of the Loysville road is a prominent ridge which slopes steeply down to the road.

The ridge is underlain mainly by the upper sandstone of the Rose Hill formation. Evidence of this can be seen in the prominent ledge present behind th house on the west side of the road and also in the grayish-red sandstone debris present along the road south of the house. The beds strike northeast along the ridge and dip steeply south.

One of the main reasons for the presence of the ridge is that the Ros Hill upper sandstone which occurs here is very resistant to erosion, and is not eroded as rapidly as the rocks in the valleys north and south of the ridge.

rhl-4 This station is located south of the Camp Entrance Road at the north end of the dam in Shermans Creek, approximately 1800 feet west of the Loysville Road.

Below the dam on the north stream bank is an outcrop of the grayish-red Rose Hill lower sandstone. The beds are medium- to thick-bedded and the bedding surfaces are irregular. The strike is north 20 degrees west and the dip only 15 degrees northeast, which means that this is nearly the crest or top of the anticline. Contrast the attitude (strike and dip) at rhl 12 and 13 with this locality

At the breast on the north end of the dam is a loose block of grayish red sandstone. Many small white fossil-shell fragments can be seen on the bedding surface.

rhl-5 This station is located on the north side of the Camp Entrance Road about 850 feet southeast of the Vehicle Bridge which crosses Shermans Creek in camp.

The outcrop at the station consists of a five to ten-foot ledge of grayish red Rose Hill lower sandstone. Note that the beds which show cross-laminat (see page 11 and figure 4) contain coarse sand grains and are characterized by small, white shell fragments. The water currents which deposited these coarse grained sediments must have been stronger than the currents which deposited the very fine-grained or mud-like sediments present at many stations.

The dip at this station is gentle northeast, and if these beds were co pletely exposed and could be traced, they would probably connect with the beds which crop out in the north stream bank at the dam. West of this station these beds cross Shermans Creek south of the Vehicle Bridge.

rhu-6 This station is located in the Main Camp area at the east end of the Vehicle Bridge on the north side of the road.

Along the eastern bank, north of the bridge, is a nearly complete exposure of the grayish-red Rose Hill upper sandstone. Within 170 feet northwest from the bridge one can walk past the inclined strata from the bottom to the top of the upper sandstone. Close inspection of these beds reveals many interesting things such as irregular bedding surfaces, casts of worm tubes lying on the bedding, cross-lamination (figure 4), variation in grain size from bed to bed and possibly a few shell fragments. The total thickness of the several sandstone horizons is 100 feet.

Between points 170 feet and 375 feet northwest from the bridge is a poorly exposed section of the uppermost Rose Hill which consists mostly of olive gray shale, very fine-grained sandstone and weathered calcareous or limy beds.

Northward from the bridge the strike of the beds changes from north 73 degrees east to north 62 degrees east and the dip changes from 37 to 45 degrees northwest.

These beds can be traced along strike, eastward, to the prominent ridge north of the Camp Entrance Road and westward to rhu 7 and 8.

North of the bridge 1000 feet, a bluff of Bloomsburg red beds can be seen on the north and east side of a bend in Shermans Creek (see b-4).

rhu-7 This station is well known to the Scouts as Eagle Rock. It is located on the east bank of Shermans Creek, west of the Main Camp buildings. At this place, the Rose Hill upper sandstone forms a small cliff and steep valley walls 30 to 40 feet high. The rock type is the same as at similar stations of this horizon. Note that fragments of the darkest colored rock are heavier than similar sized pieces of rock from other formations in the Scout Camp area. This is due to a significant, though not commercial content of iron-mineral compounds.

The strike of the beds is about north 60 degrees east and the dip is 35 to 40 degrees northwest.

Refer to the last paragraph of the description of rhu-8 for an interesting fact about stream erosion.

rhu-8 This station is on the west side of Shermans Creek, across the creek from Eagle Rock. This is one of the stops on the Camp's, "Forest and Waters Trail".

The rock which crops out here as a ledge is the upper sandstone member of the Rose Hill formation. The strike of the beds is north 60 degrees east and the average dip is 38 degrees northwest. A strike and dip symbol (figure 8) is drawn in aluminum paint on the underside of a bed at the east end of the outcrop. The arrow points in the direction of the dip.

The main beds vary from thick to thin-bedded and are characterized by thin cross laminae (figure 4). The bedding surfaces are characterized by ripple marks (figure 5), mud lumps, animal trails (?) and tube-like casts of small worms which probably lived in the marine or brackish water during the time of deposition.

Note that there are many cracks or fractures nearly perpendicular to the main bedding. The fractures are called joints and were caused by forces exert on the rocks during the period of mountain making, when the rocks were folded. A white or grayish white mineral can be seen on some of the joint surfaces. This mi eral is quartz, a very hard mineral which although brittle and breakable, is harde than steel and cannot be scratched with a nail or knife-blade. This is the mineral which is used to make glass, refractory bricks for lining iron furnaces, abrasives such as some types of sandpaper and many other commercial products. However, the amount of quartz found here is not enough to be commercially valuable. Most of the sand grains in the Rose Hill sandstones are also composed of the mineral quartz. Commercial quartz sands must be clear and white rather than dirty such as the sandstones of the Rose Hill formation.

Note that Eagle Rock (rhu-7) is northeast along strike from the ledge at this station. The two ledges were at one time continuous across the stream valley, and still are continuous as a single ledge beneath the stream valley. This shows that Shermans Creek has cut a notch in the inclined sandstone beds. Due to resistance of the hard sandstone to erosion, Eagle Rock and rhu-8 still stand as prominent ledges on the valley slopes where erosion is less rapid than in the strea valley.

rhu-9 Three thousand feet west of the Main Camp is a covered bridge across Shermans Creek, along the Valley Road. This station is located on the east bank of Shermans Creek, about 2000 feet southeast along the creek from the covered bridge.

The outcrop consists of the Rose Hill upper sandstone member and some of the shales and fine-grained, olive-gray sandstone beds which overlie the upper grayish-red sandstone. The beds strike north 65 to 70 degrees east and dip 50 to 55 degrees northwest. The rock ledge at this station is a westward contination of the ledges at rhu-8 and rhu-7.

A few shaly and sandy beds contain fairly abundant small marine fossil at this locality. The best fossil hunting is in the beds which occur a few feet north along the stream from the massive sandstone ledges.

rhl-10 This station is located near Bowers Road, an abandoned farm road, which can be followed west along the south side of Bowers Mountain. The road entrance is at a barn 2300 feet south of the Loysville Road Bridge which spans Shermans Creek. The farm road can be followed west for 7000 feet (1-1/3 miles). Then it turns from southwest to northwest, to northeast around the end of a ridge cut off by a north-south valley. Station rhl-10 is located 400 to 500 feet northeast of this turn in the road, at the crest of the ridge.

The outcrop ledge which forms the north crest of the ridge consists of massive beds of medium-gray to greenish-gray sandstone. These beds represent the lower portion of the Rose Hill lower-sandstone member. The strike of the bed is north 60 degrees east and the dip is 70 degrees southeast showing that this is the south flank or side of the Bowers Mountain anticline.

Note that the color of the beds at this station is the same as at rhl-11. The beds can be traced westward across Bowers Road at a point about 200 feet northeast of the bend in the road.

hl-11 This station is 4600 feet south 48 degrees west from the center of the Main Camp area, at the crest of a short northeast-trending ridge which flanks the main Bowers Mountain trend. There is a pine forest in an abandoned farm area at the crest of the ridge and the station can be located by walking along the north edge of the pine forest to a location approximately 200 to 300 feet northeast of the highest point on the ridge.

At the station, a small ledge of rock crops out. It is medium gray and represents the lower portion of the Rose Hill lower-sandstone member.

The strike of the beds is north 62 degrees east and the dip 40 degrees northwest. These beds can be traced east, around Paxton Peak 2300 feet east of this station and then west to rhl-10, where the dip is south, thus showing the same rocks on both sides of the Bowers Mountain anticline.

Note that the sandstone at this exposure is medium gray rather than grayish-red as are the massive sandstones higher in the Rose Hill formation.

hu-12 These stations are in a short northwest-trending valley which is notched
hl-13 into the south slope of Bowers Mountain about 800 to 900 feet west of rhl-10, or about 1-1/4 miles south 38 degrees west from camp.

Outcrops on the slopes of the stream valley include both the Rose Hill upper and lower grayish red sandstones. The average strike of the beds is north 55 degrees east and the dip is 68 to 70 degrees southeast.

The outcrops can best be located by reference to Laurel Run which flows along the base of the south slope of Bowers Mountain. The outcrop of the upper sandstone is about 750 feet northwest, up the valley from Laurel Run. The lower sandstone is 1150 to 1200 feet from Laurel Run. The outcrop of the lower sandstone can be traced continuously from rhl-10 southwest to rhl-13. The dip of this horizon varies from 70 degrees southeast to vertical.

l-14 One mile west of camp, on the north slope of Bowers Mountain, the Woods Road trends southwest and then south up the Unnamed Stream Valley, from the Valley Road. This station is located 3400 feet south of the road, on a small northeast-trending ridge west of the Woods Road.

The outcrop is a grayish-red sandstone, and is the lower sandstone of the Rose Hill formation.

Note that 800 feet northwest of this small ridge is a much larger ridge.

The crest or top of the larger ridge is underlain by the Rose Hill upper sandstone, which is thicker and more massive than the lower sandstone and forms a larger ridge due to greater resistance to erosion.

Between the two sandstone ridges is a pronounced valley which trends along the mountain. The valley is underlain by the 350-foot (?) thickness of shale which comprises the middle of the Rose Hill formation. Since the shale is less resistant to erosion than the two sandstones, it has been eroded more rapidly by stream action thus forming a valley.

South of this station is another valley, where the shale of the lower Ros Hill formation has been eroded more rapidly than adjacent sandstones.

South of the lower Rose Hill shale valley is the main part of Bowers Mountain which is underlain by the Tuscarora sandstone as can be seen at station t-1. This sandstone is very resistant to erosion and thus underlies the highest ridges in the Perry County area such as Bowers, Blue, Conococheague, and Tuscarora Mountains.

Keefer Sandstone

(Formation description on page 13)

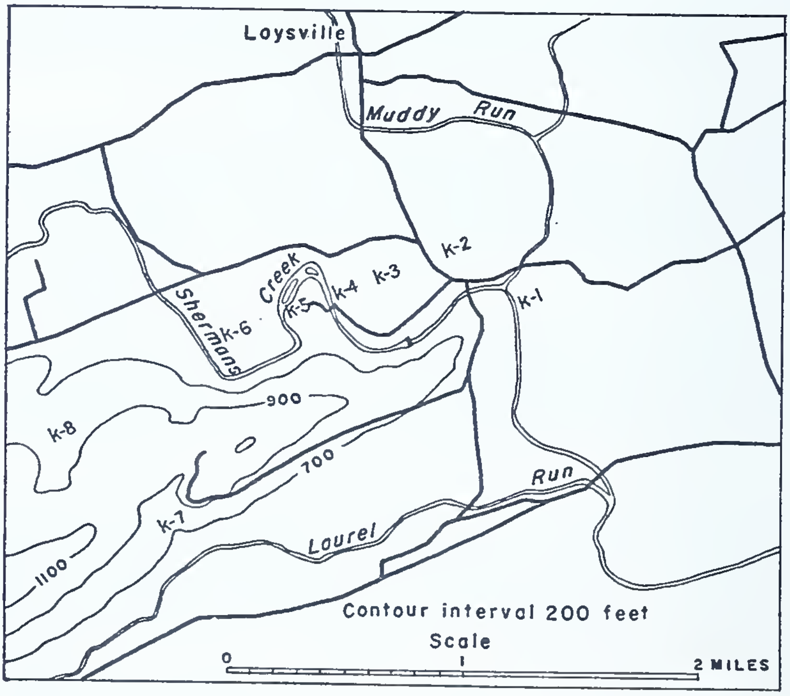


Figure 12. Locations (k-1 to k-8) of outcrops of Keefer sandstone.

This station is located east of the Loysville Road on the east side of Shermans Creek about 500 feet south of the junction of Shermans Creek and Muddy Run, or, 300 feet south of the island present at the stream junction.

The light-gray Keefer sandstone crops out on a steep slope which is a few tens of feet east of the stream. A few pine trees mark the site of the outcrop. The strike of the beds is north 47 degrees east and the dip is 47 degrees southeast.

This station is 750 feet, north 30 degrees from the junction of the Loysville and Camp Entrance Roads. It is on a moderate slope in a wooded field corner.

Large blocks of light-gray Keefer sandstone are scattered on the slope. The attitude or strike and dip of the beds is not clear, but should be moderate toward the northwest since this station is located on the north flank or side of the Bowers Mountain anticline.

On the Loysville Road, from a point 500 feet north of the Camp Entrance Road, one can look southwest along a fence row which separates wooded land from open fields. Station k-3 can be any one of many localities along this fence row. The fence row can be reached by walking 500 to 1000 feet north 30 degrees west from any point along the Camp Entrance Road.

There are many boulders of light-gray to whitish-gray sandstone along the fence row. These boulders mark the line of outcrop of the Keefer sandstone. One thing to note is that the Keefer cannot be cultivated due to its blocky nature. The field north of the fence row is underlain by the McKenzie shale and limestone. In the Perry County region, cultivated areas are often limited in this manner by rock type.

The attitude of the rocks cannot be measured here, but the fence row is along the direction of strike and the dip is 20 to 30 degrees northwest.

The location of this station is in camp, at a small borrow pit or excavation 200 feet northeast of Rotary Lodge on the east side of Shermans Creek.

The formation exposed is the Keefer sandstone, which is interbedded with shale at this station. The average strike is north 63 degrees east and the dip is 45 degrees northwest.

The total thickness of Keefer exposed is about 45 feet. The section consists of three medium-gray to dark-gray sandstone horizons, each several feet thick, separated by very fine-grained sandstone and olive-gray to dark-gray shale.

The rocks are fractured or jointed, and stained on the joint surfaces with rust-colored and black iron and manganese compounds. A golden-yellow mineral called iron-pyrite is present in minor amounts. Pyrite is composed of a mixture of iron and sulphur, the sulphur producing a yellow color. Where found in minable quantities with other valuable minerals, sulphur is extracted or taken from pyrite to make sulphuric acid, although there is not enough pyrite in this area for such use.

Abundant marine fossils are present in the fine-grained shale beds between the upper and middle sandstone horizons. Those who visit this station should be able to find some.

The sandstone can be traced from this station southwestward across Shermans Creek to the Main Camp area at k-5.

k-5 This station is in the center of the Main Camp area. To find this stati cross Shermans Creek from east to west on the Vehicle Bridge in camp. Continue on the road, which at the west end of the bridge turns northwest for about 400 feet and then southwest. This station is on the slight incline of the southwest trend.

The rock which crops out as a trend of medium gray boulders is the Keefer sandstone. As one goes from northeast to southwest along the road, the Keefer is first southeast of the road. The road trends diagonally across the Keefe outcrop, after which point the Keefer is west and then northwest of the road. The boulder trend can be followed southwest to the bank of Shermans Creek, where it crops out, dipping 50 to 60 degrees northwest.

k-6 This station is on the east bank of Shermans Creek, 1600 feet southeas along the creek from the Valley Road Bridge located 3700 feet west of the Main Camp area. The station is among some trees, a few feet west of a field corner, c the south side of a small depression 10-feet deep which has been cut into the bank Shermans Creek.

The rock which crops out is the Keefer sandstone, and it shows the characteristic medium to light-gray color on the weathered surfaces. The strike is north 65 degrees east and the dip is 60 degrees northwest.

The outcrop is not very large, but it is bedrock and illustrates the eas with which the Keefer sandstone can be traced. The beds strike approximately alo the fence row east of this station toward k-5 in the Main Camp area.

k-7 This station is located on the south side of Bowers Mountain about 1-1/ miles southwest of camp in the same northwest-trending valley described under stations rhu-12 and rhl-13. The station can be located by pacing 470 feet up the valley from its junction with Laurel Run.

The light-gray Keefer sandstone crops out on both sides of the valley and in the valley bottom. The beds are thick and well exposed. The strike is nort 55 degrees east and the average dip is 68 degrees southeast.

k-8 One mile west of camp, the Woods Road trends southwest and then sou up the Unnamed Stream Valley from the Valley Road which trends northeast along the foot of Bowers Mountain. This station is located along the Woods Road, 2300 feet south of the Valley Road. It can be recognized as the place where the stream valley becomes narrow as one walks from north to south.

The rock which crops out is the Keefer light-gray to brownish-gray sandstone. Many large blocks of Keefer clutter the valley of the small stream. The beds strike across the stream north 65 degrees east and dip 30 to 35 degrees northwest. A trend of boulders which represents the Keefer line of outcrop can be followed northeast and southwest along the mountain from the station.

McKenzie Shale and Limestone
(Formation description on page 13)

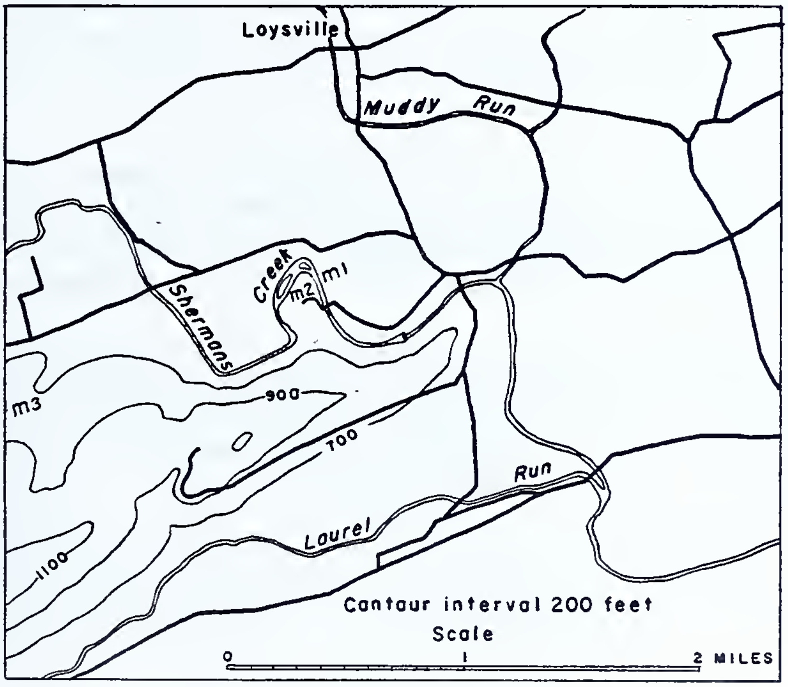


Figure 13. Locations (m-1 to m-3) of outcrops of McKenzie limestone and shale.

This station is located in the Main Camp area about 550 feet northwest along the east bank of Shermans Creek from the Vehicle Bridge. It is on the northwest side of a shallow northeast-trending depression or valley which is 150 feet wide.

McKenzie shale crops out at m-1. It is medium to thin bedded, and the color varies from olive to medium gray. The shale is interbedded with beds which are dark brown and soft. These represent limestone beds from which the lime has been dissolved, leaving a residue of clay, rich in organic material.

The small valley south of station m-1 is also underlain by McKenzie beds. These beds are less resistant to erosion than adjacent rocks, and thus as shown here, a small valley is eroded where the McKenzie outcrop should occur.

The strike of the beds is north 67 degrees east and the dip is 45 degree northwest. Note that this is similar to the strike and dip of the Keefer at k-4. The Keefer beds can be traced from k-4 southwest under the Rotary Lodge to the bank of Shermans Creek on the south side of the small valley at m-1. It can be see that the Keefer sandstone dips under the McKenzie beds. Thus if a well were drill at m-1, the drill would penetrate the Keefer approximately 200 feet below the surf of the ground.

m-2 This station is located in the Main Camp area. It is at the base of a gentle slope underlain by the Keefer sandstone as described in k-5, and is the site of a slight depression, especially as one walks either north 60 degrees east or sou 60 degrees west from the station toward Shermans Creek, which makes a horse-sh turn around this part of the camp area.

The depression at m-2 is underlain by McKenzie shale and limestone, the same as at station m-1. Outcrop ledges are not present, but small fragments of yellowish weathering shale can be found in the soil. These are rock fragments which gradually are being decomposed in the soil forming process.

The strike and dip of the beds cannot be measured at this station but is the same as at k-5 where the Keefer sandstone is seen dipping north under the McKenzie beds. When the excavation was made for the swimming pool in the Main Camp area, the McKenzie-Bloomsburg contact was exposed about half-way between the north and south ends of the pool.

m-3 This station is located on the west bank of the Unnamed Stream located one mile west of camp. The station is approximately 1500 feet south along the stream from the intersection of the stream and the Valley Road.

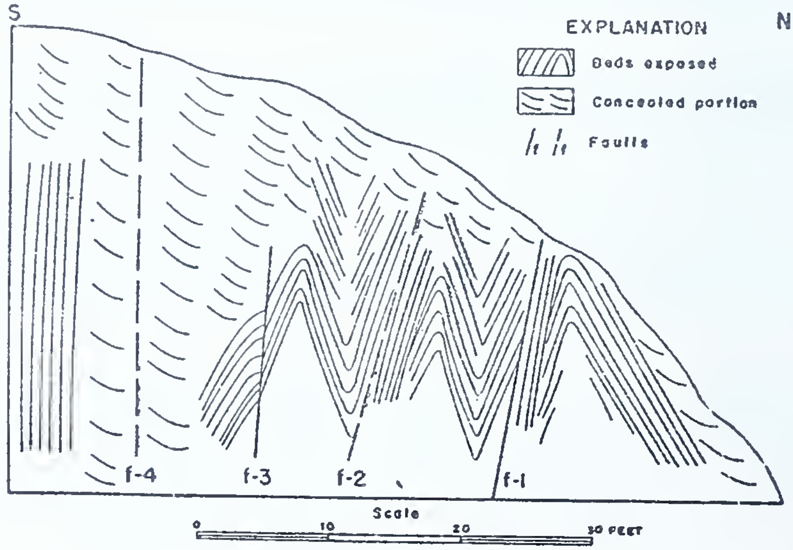


FIGURE 14. LOCALITY m-3. DIAGRAM OF STREAM SECTION SHOWING FOLDED BEDS OF McKENZIE LIMESTONE AND SHALE.

Beds of the McKenzie limestone and shale crop out on the west stream bank as shown in figure 14. This station is of special interest because the beds exposed are folded or crumpled, and broken by small faults. At the north end of the outcrop the dip is steep northwest and at the south end it is steep southeast. Thus the complete outcrop consists of an upfold or anticline complicated by smaller folds and minor faults. Although this station illustrates the manner in which beds of rock can be folded, not all of the rocks in the camp area are folded as severely as at this outcrop.

Bloomsburg Formation

(Formation description on page 14)

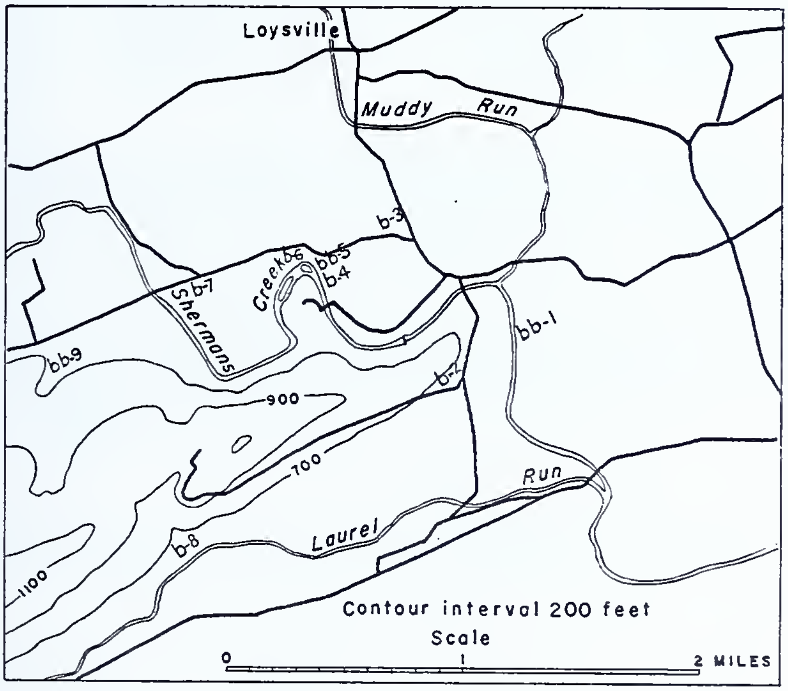


Figure 15. Locations (bb-1 to bb-9) of outcrops of Bloomsburg.

This station is located nearly a mile southeast of the Main Camp area on the east side of Shermans Creek. It can be located by walking 800 feet east along a dirt road from the north end of the Loysville Road Bridge, and then 1600 feet south along the east bank of Shermans Creek. Persons not wishing to cross Muddy Run at this spot can cross the Run at the small bridge farther east along the road.

The bedrock exposed at the station is the light-gray Bridgeport sandstone member of the Bloomsburg formation. The strike of the beds is north 52 degrees east and the dip is 60 degrees southeast.

The traverse south along Shermans Creek to the station is interesting because half the thickness of the Bloomsburg red beds is well exposed. The dip varies from 38 to 80 degrees southeast. The Bridgeport sandstone is located at the south end of the exposure.

Many joints or fracture surfaces are present in the red beds and are inclined nearly perpendicular, or at right angles, to the bedding. It is commonly difficult to distinguish bedding from joint surfaces where rocks have been deforme a great deal.

b-2 This station is located on the west side of the Loysville Road, about 1500 feet south of the Loysville Road Bridge.

The rocks exposed are part of the red Bloomsburg formation. The be strike north 55 degrees east and dip 60 degrees southeast. Note the joint fracture which strike north 55 to 60 degrees east and dip from 45 degrees northwest to vertical. When the joint fractures are very closely spaced (one inch or less) they are commonly called cleavage.

Note that by looking northeast along strike, one can see that these bed strike or trend toward the red beds exposed along Shermans Creek north of bb-1. If it were possible to clean all the soil and gravel from the bedrock in the valley o Shermans Creek, one could walk continuously on red beds from this station to tho north of bb-1. Thus, the red beds at one time extended as a continuous ridge acr the present site of the valley and have been notched or eroded by Shermans Creek The material that performs the eroding is not the stream water, but the sand, gr and mud carried and bounced along the stream bottom, especially in times of floo Man's use of sandpaper to shape or mold working materials results from a lesson learned from the natural world, where sand and water have been shaping and wea down mountains for millions of years.

b-3 This station is located on the west side of the Loysville Road about 12 feet north of the entrance to the scout camp road. It is located on a small road c 200 feet north of a barn also on the west side of the road.

The beds exposed are the Bloomsburg red beds. The strike is north degrees east and the dip is 50 degrees northwest. Note the crumpled, steeply dip beds in the north half of the outcrop.

At the north end of the exposure are some greenish-gray and yellowis beds of shale and very fine-grained sandstone. There are also a few loose boulde of light-gray sandstone. These light-colored rocks probably represent the Bridg port sandstone member, and if projected southwest along strike are seen to be equivalent to station bb-5.

b-4 and b-4 is located about 700 feet northwest along the east bank of Sherma
bb-5 Creek from the Main Camp Vehicle Bridge.

The rocks exposed are the Bloomsburg red beds, which make a steep slope and small cliff along the stream. The strike of the beds is north 67 degrees east and the dip is 45 degrees northwest.

The contact between the Bloomsburg red beds and the McKenzie medium gray limestone and shale (station m-1) is exposed at the south end of the outcrop.

The Bloomsburg beds exposed can be traced continuously around the east end of Bowers Mountain to the beds exposed north of bb-1. Note that here the beds dip 45 degrees northwest, whereas at bb-1 the average dip is 60 degrees southeast. The beds at the two stations dip oppositely because they are on opposite sides of the Bowers Mountain anticline.

The Bridgeport sandstone is exposed north of this station. It is labeled bb-5 on the geologic map and can be found easily by walking north 20 degrees west along the top of the east stream bank for a distance of 360 feet from the Bloomsburg-McKenzie contact. The whitish to light-gray sandstone is easily recognized among the red Bloomsburg debris. The beds are only partially exposed, but are probably 10 to 15 feet thick.

This station is located north of the main camp area, on the south side of the Valley Road about 3300 feet west of the Loysville Road. From the station, one can walk south down a steep dirt road in a narrow valley to Shermans Creek.

Along the west bank of the steep dirt road there is almost continuous outcrop of the Bloomsburg red beds from the station to the flat valley-bottom along Shermans Creek. The strike of the beds is north 65 degrees east and the average dip is 45 degrees north.

Note that the width of the Bloomsburg outcrop belt shown on the geologic map at this station is wider than normal. The extra width is due mainly to a small anticline or upfold existent between stations b-4 and b-6. The fold is a continuation of the one which is seen exposed to the southwest at m-3 (see figure 14).

This station is located half a mile west of the Main Camp area. It is 700 feet northeast of Shermans Creek, as measured from the covered bridge, northeast, along the Valley Road.

A moderately steep slope 10 to 30 feet high trends southeast from the road and parallel to Shermans Creek. Evidence of the Bloomsburg red shale and sandstone beds can be seen along this slope for a distance of 1200 feet southeast of the road. At some places bedrock crops out. In other places red soil can be seen, which indicates that the Bloomsburg red beds are near the surface under a thin cover of soil derived from the rock.

This station is located in a stream valley on the south side of Bowers Mountain, 1-1/4 miles southeast of camp. It is confined to the valley between the stream junction with Laurel Run and a point 300 feet north or up the small valley.

Bloomsburg red shale and sandstone crop out in the valley bottom. strike of the beds is north 55 degrees east and the dip is 68 degrees south. The contact between the Bloomsburg red beds and the underlying McKenzie olive-col beds can be seen at the spot cited as 300 feet from Laurel Run. At this locality McKenzie beds at the contact are fine-grained sandstone and shale.

Persons interested can continue up the valley and see stations k-7, rhu-12, and rhl-13.

bb-9 This station is 1-1/4 miles west of the Main Camp area along the U named Stream which flows down the north slope of Bowers Mountain. One can reach this station by pacing 1000 feet south along the stream, starting from the small bridge where the Valley Road crosses the stream.

At the station, bedrock crops out along the steep west bank of the st Both sandstone and shale are present. Some of the sandstone is stained browni on the surface, but when broken, the fresh surface is a pale-olive brown rather red as are the shales at this outcrop. The light-colored beds are the Bridgepo sandstone member of the Bloomsburg red beds. This member can be seen also at bb-1, and bb-5.

The strike of the beds at bb-9 is north 65 degrees east and the dip i 35 degrees northwest. Compare the dip at this station with that at b-8 on the so side of the mountain where the dip is 68 degrees southeast. The dips are oppose and show that at one time the red beds extended over the present-day surface of Bowers Mountain. For millions of years, the rock has been decomposing into As the soil forms it is carried away by rainwater and the action of streams. G ally the land surface has been worn away in the past and will continue to be wor away in the future, until the mountains are reduced to small hills. Perhaps the another mountain-making period will occur and the process will begin again. It should be realized that these processes are very slow and require millions of y for significant changes.

Wills Creek Formation

(Formation description on page 15)

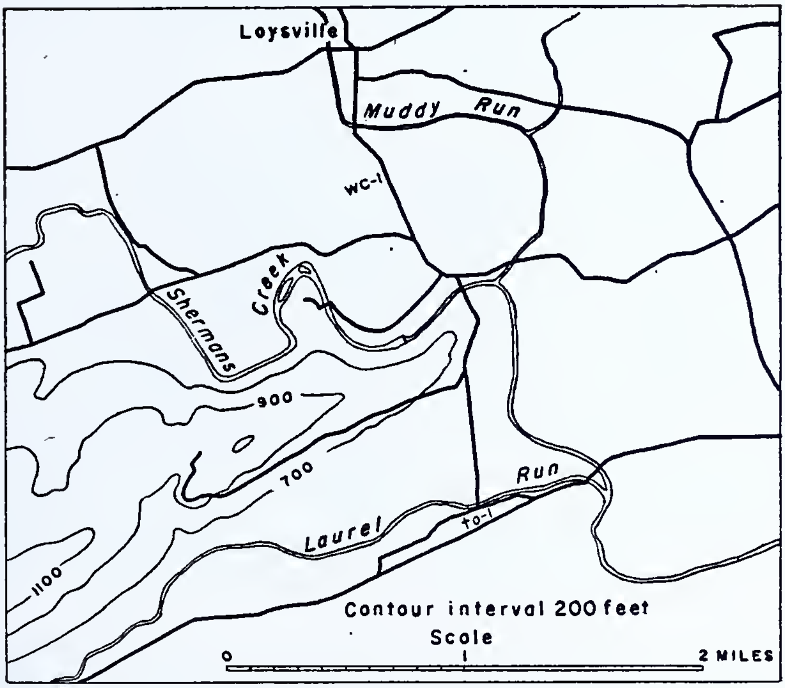


Figure 16. Locations (wc-1 and tp-1) of outcrops of Wills Creek shale and Tonoloway limestone.

This station is located 2600 feet north along the Loysville Road, from the Camp Entrance Road.

On the west side of the road, south of a farm lane, red and gray-green beds of shale are exposed. These beds are part of the Wills Creek formation and differ from the Bloomsburg formation, which is almost totally red as well as a deeper red.

Some of the Wills Creek gray-green beds at this locality are limy or calcareous and will fizz or bubble slightly when a drop of dilute hydrochloric acid is placed on the rock.

Note on the geologic map (plate 2) that this formation underlies much of the area surrounding the Boy Scout Camp. A few small bean-shaped fossils are present at this station, although fossil collecting is much better in camp at k-4.

The strike of the beds at this station is north 55 to 60 degrees east and the dip is 50 degrees northwest. North of this station in the south part of Loysville, these same beds dip southeast. Thus the structure between wc-1 and Loysville is a syncline or down-fold.

Tonoloway Limestone

(Formation description on page 16)
(Station location - see figure 16)

to-1 This station is located south of Bowers Mountain, about 1-1/4 miles southeast of camp on the south side of the bridge across Laurel Run where the Loysville Road intersects the Landisburg Road. Bedrock at the station is seen o the south side of the intersection.

The rock which crops out is the greenish-gray to medium-gray Tonol way limestone. The limestone contains some clay and is not a good grade of lim stone, but it is of interest because fossil mudcracks can be seen on the bedding surfaces. The beds dip northeast toward the observer, and the bedding surface i broken by many intersecting lines resembling the cracks in a dry mud puddle. These cracks indicate that when the limy sediments in the rock were being deposi this station must have been near the shore of a sea, in shallow water. After the seen here was deposited, it was exposed to air by gentle raising of the coastal ar or lowering of the sealevel, owing to tidal affects or a similar cause. Exposure air caused the sediments to dry out, forming mud cracks much the same as they form on the bottom of a pond which has been drained, or a mud puddle in dry wea Later, when the surface was covered with water again, lime mud was deposited i the cracks preserving them as they are seen today at this outcrop. It is interesti to realize that these mud cracks are approximately 350 million years old.

The surfaces of some of the beds at this station are covered with man small bean-shaped fossils called ostracods. Similar fossils are found also in the Wills Creek formation.